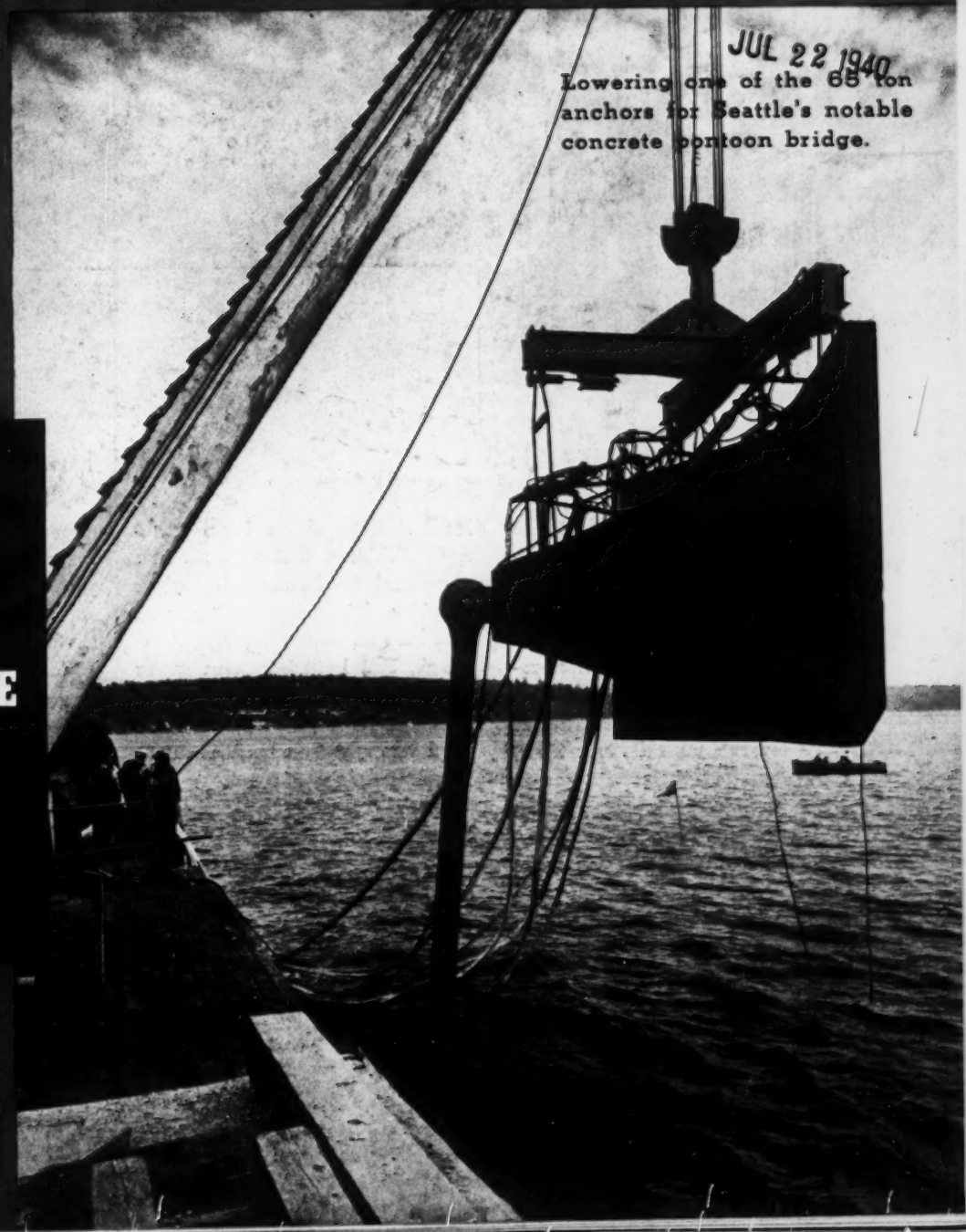
ENGINEERING NEWS-RECORD

JUL 22 1940



Lowering one of the 65 ton anchors for Seattle's notable concrete pontoon bridge.

JULY 18
1940

SABOTAGE and TER SERVICE

port to municipal au-
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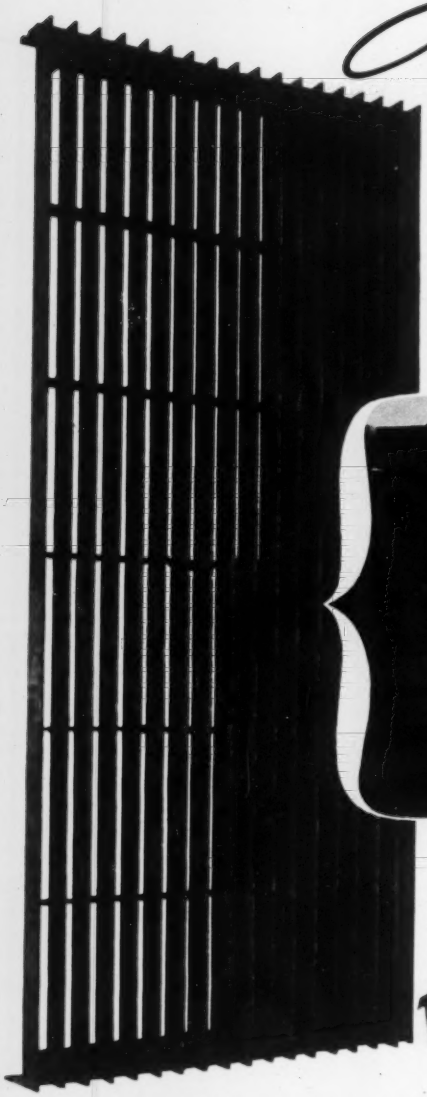
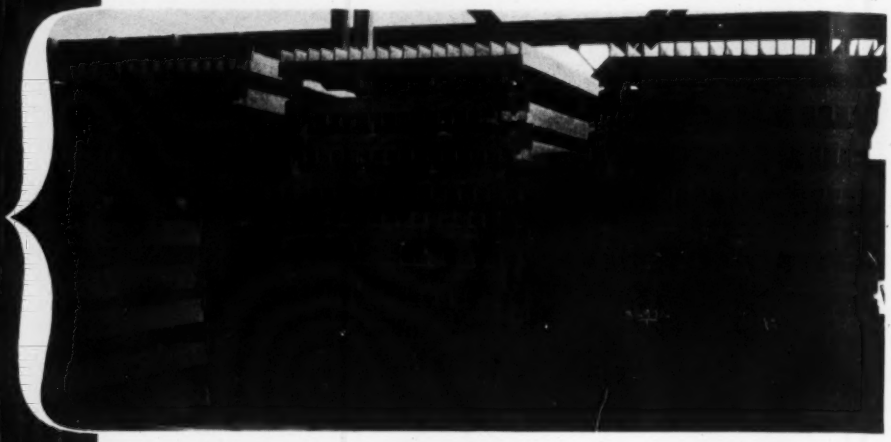
ials — *See page 50.*

These Grand River Dam

TRASH RACKS

ARE BUILT TO TAKE A BEATING





BYERS WROUGHT IRON

Every engineer can appreciate the extremely severe service conditions that trash racks must face. Because wrought iron combines to an exceptional degree the physical properties and the corrosion-resisting qualities needed for the job, it was used in this large order of racks for the Grand River Dam, near Pensacola, Okla.

The superiority of wrought iron for this service is generally recognized; 241 all-welded trash racks built of Byers Wrought Iron were used in the Fort Peck Dam alone.

Many municipalities have trash-rack problems, that wrought iron can—and is—helping to solve. Brookline, Mass., has used wrought iron bars for sewer gratings; Pittsburgh, Pa., built 35 storm sewer buckets of wrought iron plates, bars, and angles; the City of Buffalo used wrought iron trash racks in its sewage disposal plant.

If you have any similar problem in connection with trash racks, or other applications in drainage lines or sewage disposal systems where corrosion is causing trouble and expense, our Engineering Service Department will be glad to give you data from our files on the service life of wrought iron under similar conditions. In the bulletin, "Wrought Iron for Sanitary Systems," you will find some helpful information on corrosion in sewage treatment and disposal systems. We will send you a copy on request.

A. M. Byers Co., Pittsburgh, Pennsylvania. Established 1864. Boston, New York, Philadelphia, Washington, Chicago, St. Louis, Houston, Seattle, San Francisco.

CORROSION
COSTS YOU MORE THAN
WROUGHT IRON

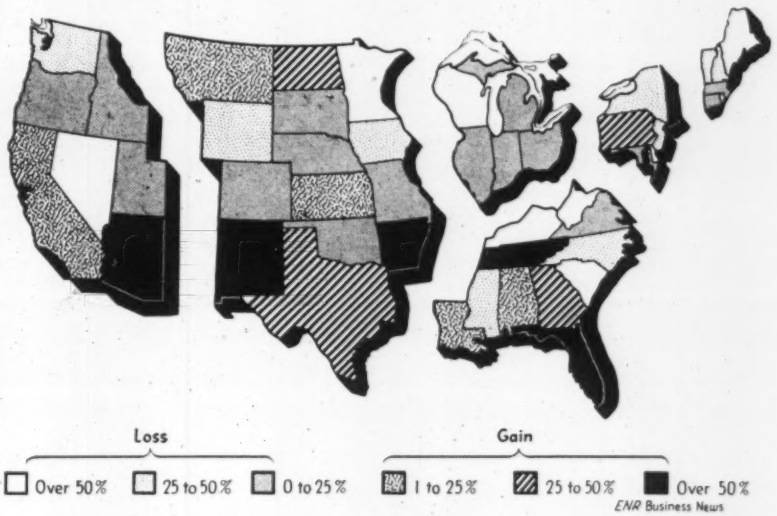
BYERS GENUINE WROUGHT IRON
TUBULAR AND FLAT ROLLED PRODUCTS
STEEL TUBULAR PRODUCTS

CONSTRUCTION TRENDS

Notes on significant movements in the construction industry

DISTRIBUTION OF *ENR* CONSTRUCTION GAINS AND LOSSES

First Half of 1940 Compared with 1939



Industrial building reacts to defense spending

THE FIRST HALF of 1940 produced $1,389,616,000 in new engineering construction contracts according to *Engineering News-Record* reports. This volume was 11 per cent lower than in 1939 when a fixed closing date for PWA contracts produced an abnormal peak, but it has topped all other first half totals since 1931.

Three geographical sections of the country reported increases over a year ago, South gained 14.3 per cent over its record-breaking 1939 total, Far West was up 9.1 per cent, and West of Mississippi just topped last year by 0.2 per cent.

Pennsylvania exceeded last year by 26 per cent and was the only state in either the New England, Middle Atlantic or Middle West regions to report an increased volume.

Substantial gains were registered in four of the Southern states: Tennessee, 400 per cent; Florida, 161 per cent; Georgia, 48 per cent; and Louisiana, 22 per cent. The Alabama volume was up 2 per cent for the fifth gain in the area.

Six states in the West of the Mississippi region—New Mexico, Arkansas, North Dakota, Texas, Montana and Kansas—exceeded their 1939 six-month values, reporting gains ranging from 298 per cent in New Mexico to 5 per cent in Kansas.

Arizona and California with increases of 241 and 23 per cent, respectively, were responsible for the 9 per cent gain in Far West volume.

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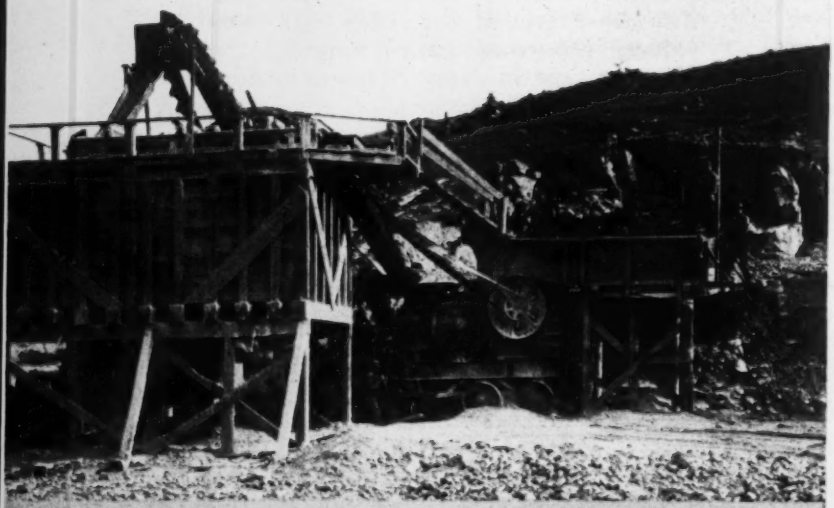
In Oregon, McNutt Bros. of Eugene, use a Pioneer Quarry Plant with a 2436 Primary [illegible] Roll Crushers to produce six sizes — control the amount of each and recrush any excess.

SAVE ON QUARRY AGGREGATES •

In Texas, Ernest Loyd of Fort Worth, uses a Pioneer Quarry Plant with Traveling Grizzly Feeder — 2436 Jaw Crusher and Roll Crusher to crush and screen caliche.



In Virginia, the Mundy Lime & Stone Company use Pioneer Crushers, elevator and screen to produce and separate four sizes of crushed rock.

In Maryland, Garrett County uses two Pioneer No. Quarry Plants to produce their road surfacing mater

WITH PIONEE

You, too, can save money by p ducing your aggregates in a Pion Quarry Plant. Regardless of wh the job may be—Pioneer can h you.

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F. E. SCHMITT AND WALDO G. BOWMAN, *Editors* • ALBERT E. PAXTON, *Manager*

Vol. 125 JULY 18, 1940 No. 3

THIS WEEK

• How ten million tons of concrete aggregates are to be transported over a 9.6-mile belt conveyor system arranged in twenty-six flights 850 to 3,240 ft. long from the processing plant at the quarry to the mixing plant, is tersely told—Belt Takes Aggregates to Shasta.

• That structural welding is beginning to be used with full appreciation of its special possibilities and problems is emphasized by two important articles in this issue. One describes a rigid frame bridge at Cleveland which introduces a three-plate flexible web detail that is as ingenious as any of the bold European designs. The other covers the design of the Air Lines Terminal, largest all-welded building in New York and one in which a variety of difficult framing is accomplished by special joints that illustrate the necessary difference between welding and riveting design.

THINGS TO COME

• Construction Contracts for the Defense Emergency—a timely discussion of this vital problem by Louis B. Wehle, will appear in Aug. 1 *News-Record.* Mr. Wehle speaks with authority on this subject. In 1917 he was counsel to the War Industries Board, served as assistant to the Secretary of War and held other important war-time posts. He drafted the form of the well-known cost-plus-percentage contract, and still holds that it offers advantages for certain types of work.

• Houses Built to Last 60 Years—an approach to California's housing problem, wherein quantity production, precast floor joists and a new type of "wrinkled" floor form play an important part in the solution.

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Number of copies of this issue printed: 34,949

1- You're looking through the Sideling Hill Tunnel after ceiling slab was placed. By using Atlas High-Early for this ceiling, work was completed in a fraction of the time that would have been necessary using regular portland cement. Pictures below show how.

Consulting engineers, Greiner & Co.; Contractors, The Arundel Corp., both of Baltimore, Maryland.

SIDELING HILL TUNNEL *finished faster*

WITH AID OF

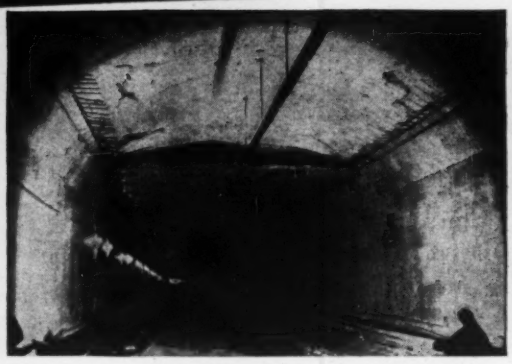
ATLAS HIGH-EARLY CEMENT

"RUSH" is the order recently given for all work on the Sideling Hill Tunnel. This is necessary to insure construction being completed in time for the scheduled opening of the great Pennsylvania Turnpike on July Fourth.

One of the most important construction speed-ups has been made in the concreting of the horizontal slab which forms a ceiling for the tunnel. Many days' time has been saved on this work by shifting from regular portland cement to Atlas High-Early—the cement that gains working strength in a fraction of the usual time. In addition to saving many hours of curing time, and speeding up stripping of forms, use of Atlas High-Early made possible top-speed concreting with only two sets of forms instead of four.

Now, you may never build a tunnel like this. But many times a year you plan or carry out concreting work which offers you similar opportunities to reap substantial time- and money-savings . . . by specifying Atlas High-Early cement. So try out this cement that gains strength so fast, on your next job. Universal Atlas Cement Co. (United States Steel Corporation Subsidiary), Chrysler Building, New York City.

2 Just before placing the ceiling slab in the Sideling Hill Tunnel, longest of the seven tunnels of the new Pennsylvania Turnpike. This tunnel is 6782 ft. long, 28 ft. 6 in. wide, and will carry two lanes of traffic. When placed, the ceiling slab turns the upper part of the tunnel into a huge air duct.



3 See how the ceiling slab was placed. The contractors cast 90 ft. slabs in alternate sections so that there was always one section open between the placing operations. The use of Atlas High-Early cement cut curing time substantially, allowed much earlier stripping of forms, and saved two sets of forms.

4 Picture taken standing on the ceiling slab. These slabs are 5 in. thick and are held up by special steel suspension rods from the center of the arch. See the intervening spaces between sections. Over 3,000 linear ft. of the ceiling slab have been placed to date.

ENR-H-1f

ATLAS HIGH-EARLY CEMENT

A UNIVERSAL ATLAS PRODUCT

The Week In Engineering and Construction

Biggest construction week in history is recorded

Bureau of Yards and Docks lets $140,000,000 in contracts to push nation's weekly volume to $217,000,000. Army adds $30,000,000 with a powder plant.

Never before in history has such a volume of construction contracts been let in one week as were placed on the books in the seven days ending Tuesday, July 16. The total was $217,000,000. Only $170,000,000 of this amount is carried in *ENR's* statistics, since the remainder is outside the continental U. S. and has previously not been considered domestic construction. Justified as this may be for comparative statistical purposes, the fact is that U. S. contractors received $217,000,000 worth of business. Two weeks in the spring of 1929 recorded totals of $160,000,000 and in one week in March, 1930, there was a $182,000,000 figure, which was the record until today.

Principal credit for the huge contract totals goes to the Bureau of Yards and Docks of the Navy Department, which awarded nearly $140,000,000 of work on its cost plus a fixed fee basis. The speed with which this letting was handled is evident from the fact that the bill asking for the money was introduced into Congress less than a month ago.

Naval base work accounts for the lion's share of the total as is evident from the following list:

Quonsett Point, R. I.—$24,204,000 to George A. Fuller, New York, and Merritt-Chapman & Scott Corp., New York.

Pearl Harbor and islands in western Pacific—$30,870,000 to Raymond Concrete Pile Co., New York; Turner Construction Co., New York; Morrison-Knudsen Co., Los Angeles, and J. H. Pomeroy & Co., Inc.

Norfolk, Va.—$12,700,000 to Virginia Engineering Co., Newport News.

Bremerton, Wash.—$7,300,000 to Austin Co., Cleveland, Ohio.

Guantanamo Bay, Cuba—$5,190,000 to Frederick Snare Corp., New York.

Alameda, Calif.—$9,800,000 to Johnson Drake & Piper, Inc., Minneapolis.

Coco Solo, Canal Zone—$11,050,000 to Lindgren & Swinnerton, San Francisco; Hegeman-Harris Co., New York, and Tucker McClure.

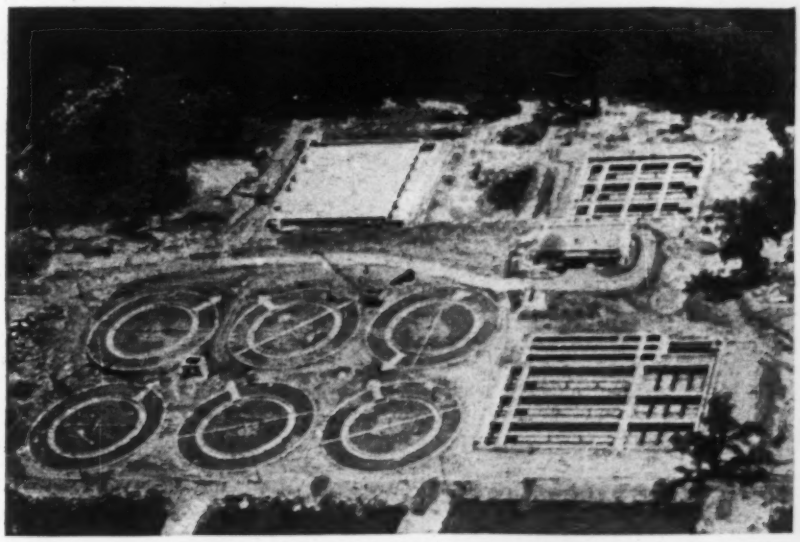
Pensacola, Fla.—$4,000,000 to Hardaway Contracting Co., Columbus, Ga.

Miami, Fla.—(Opa Locka)—$3,500,000 to Fred Howland, Inc., and Jack Quinn, Inc., Miami.

Jacksonville, Fla.—$12,786,000 to Duval Engineering & Contracting Co., Jacksonville; George D. Auchter Co., Jacksonville, and Batson Cook Co., West Point, Ga.

San Diego, Calif.—$3,313,900 to M. H. Golden and Walter T., Los Angeles, California.

In addition, Navy contracts covered power plant improvements at New Haven to Stone & Webster Engineering Corp.,



New plant to aid in clean-up of Mississippi River

Another step in cleaning up the Mississippi River in the Twin City area was taken this month when the new $1,250,000 sewage disposal plant was placed in operation at South St. Paul. The plant, located on the Mississippi River just south of the Armour packing plant, will treat the sewage from the South St. Paul stockyards, the Swift & Company packing plant, the Armour Co. packing plant and the city of South St. Paul, which has a population of about 12,000.

The new plant, which was started in October, 1939, was built by the Okes Construction Co., St. Paul, with Charles Palda acting as superintendent. The electrical work was done by the Peoples Electric Co., St. Paul; plumbing and heating by Math Gish, South St. Paul, and sewer work by Lindahl, Gustafson & Klopfer, Minneapolis. The plant was designed by Consoer, Townsend & Quinlan, Chicago with R. A. Young acting as resident engineer. William H. Cropsey is city engineer of South St. Paul.

As a further step in the clean-up of the Mississippi at the Twin Cities, the Cudahy Packing Co. on the east bank of the river is making arrangements to construct its own treating plant. The sewage treatment plant of the Minneapolis-St. Paul Sanitary District went into operation in June, 1938.

for $1,325,000; explosives plant at Boston to Tredennick-Billings Co. for $585,000; power plant at Iona Island, N. Y., to J. G. White Engineering Corp. for $740,000; hangar at Washington, D. C., to Jeffress-Dyer, Inc., for $225,000; barracks at San Diego to Los Angeles Contracting Co. for $1,630,000; a shop extension at Norfolk to Rust Engineering Corp. for $720,000; and power plant improvements at New London, Conn., to Stone and Webster, $1,325,000.

Huge plant for smokeless powder

Biggest single item in the week's total was contributed by the War Department with a $30,000,000 powder plant near Jeffersonville, Ind., across the river from Louisville, Ky. Planned for a daily output of 200,000 lb. of explosives, the plant will be built and operated by E. I. duPont de Nemours & Co. Construction presumably will be done with the company's own forces, following the precedent set on its work current on the British-financed Tennessee Powder Co. plant at Memphis.

BRIEF NEWS

THE LANSDALE (Pa.) Borough Authority has purchased the City of Lansdale's water system from the Lansdale Water Co. for $436,200. The system will be operated by the borough authority until a $450,000 bond issue to finance the purchase has been retired, then it will be turned over to the city.

THE PENNSYLVANIA TURNPIKE, 160-mi. express highway being built between Harrisburg and Pittsburgh at a cost of $70,000,000, will be dedicated Labor Day, according to a tentative date set by the Turnpike Commission. Originally the superhighway was scheduled to open July 4, but paving contractors were delayed by bad weather.

CONTINUATION of construction by the Mississippi State Highway Department has been assured with the sale of a $2,000,000 series of the authorized $60,000,000 highway revenue bonds. The bonds, sold for $2,002,600 with interest at 3 per cent, will enable the highway commission to sign new contracts and meet payrolls until September.

INAUGURATION of a highway economics division to gather and distribute information and data on highway construction and maintenance has been announced by the American Road Builders Association. Known as the first "Highway Laboratory," the new division is expected to aid in stabilizing road expansion expenditures in accordance with fluctuating amounts of federal funds, gas taxes and registration fees.

THE ATTORNEY GENERAL of Arkansas has ruled that the contractors' license law, Act 124 of the Acts of 1939, will apply to contracts let by housing authorities. This law requires all contractors handling construction work of more than $10,000 to be licensed by the state of Arkansas.

Arnold & Kellogg photo

Construction begun on New York parkway connecting link

Structures are nearly all under contract for a 3½-mile $8,300,000 extension of the Hutchinson River Parkway to connect it with the Bronx-Whitestone Bridge by a six lane divided highway. When completed this connection will give a direct express route between the parkway systems of Long Island and Westchester County and will relieve congestion on Eastern Blvd., the circuitous surface connection now carrying through as well as local traffic.

Shown in the foreground is the start of North-Eastern Construction Co.'s contract for the substructure of the Eastchester Creek bridge which will have a bascule span 160 ft. 6 in. c.c. of trunnions. Two separated 36-ft. roadways are carried on four movable sections, a double leaf being provided for each direction of traffic. Another major development will be at Eastern Boulevard (see end of dotted line) where 3 bridges are required to separate traffic.

Gun Hill Road, Pelham Parkway and Westchester Ave. (on the curve) will have access ramps to the new highway.

Illinois hospital head ousted in typhoid case

A. L. Bowen, who as state welfare director of Illinois was in charge of the Manteno, Ill., Hospital where 60 typhoid deaths resulted last year (*ENR*, Oct. 26, 1939, p. 517; April 18, 1940, p. 552), has been ordered removed from office by an Illinois circuit judge. The court has also fined Bowen $1,000.

It was claimed that Bowen ignored repeated warnings given by the state division of health that the water supply for the hospital was contaminated.

• • •

Professional employees status to be studied

Status of professional employees in the construction industry will be considered July 25 at the last of four hearings held by the Wage-Hour Administration on the desirability of changing the present definitions of professional, executive and administrative employees. These groups are exempt from the provisions of the law, but some employers have felt that the adopted definitions of the terms bring under the act employees who should properly be excluded. This view has been opposed by labor groups at previous hearings.

Amendments to the Wage-Hour Act which were before Congress this spring were understood to have been dropped on the understanding that administration of the act would be modified.

Closing date for those desiring to testify at the July 25 hearing is July 23.

• • •

A. N. Johnson Dies; former Maryland dean

Arthur N. Johnson, 69, dean emeritus of the college of engineering at the University of Maryland where he had been dean from 1920 to 1936, died in Baltimore, July 11. Following graduation from Harvard University in 1894, Johnson was employed by the Massachusetts Highway Service, becoming its chief engineer in 1898. Later he assisted and advised in construction of Maryland's first hard surface road system. Johnson gave up the position of chief roads engineer for Maryland in 1905 to become chief engineer of the U. S. Office of Public Roads, now the Public Roads Administration. Soon afterward he was made state highway engineer of Illinois, a position held for eight years or until leaving to work as consulting engineer for the Portland Cement Association.

Following 16 years as engineering dean at Maryland, Johnson retired in 1936 as dean emeritus. He was a past president of the American Society of Civil Engineers.

Johnson had also worked for the Maryland geological survey and the City of Baltimore, and early in life taught at Harvard University. He had published many articles on highway design and construction.

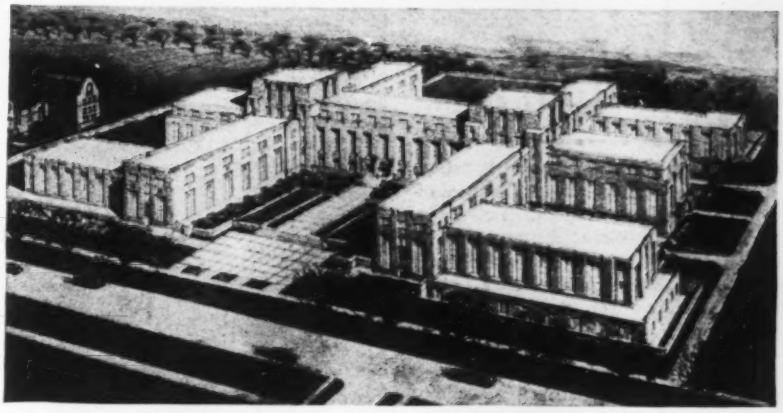
In 1913 Johnson represented the United States in an international highway conference in Paris, and in 1925 was appointed by President Coolidge as an American delegate to the Pan-American Road Conference.

• • •

Firm fails to supply piling; must pay damages

Judgments totaling $59,063 have just been signed in U. S. District Court at Elizabeth City, N. C., against the Gulf States Creosoting Co. of Hattiesburg, Miss., for breach of contract in failing to deliver creosoted pilings on time for a $1,500,000 bridge across Albemarle Sound in North Carolina and for delivering the pilings "in promiscuous manner and in irregular lengths." The judgments were awarded in suits brought by T. A. Loving & Co., Goldsboro, N. C., and the Tidewater Construction Co., Norfolk, Va., the first getting an $18,186 judgment and the latter a $40,876 judgment as against claims of $50,000 and $60,000 respectively.

The bridge was completed and opened to traffic in August, 1938.



How Northwestern's Technological Institute will appear

Construction has begun at Northwestern University on the new $5,000,000 Technological Institute building, which is shown in the above drawing. Scheduled for use by September of next year, the building will cover a 505x347 ft. area between Sheridan Road and the shore of Lake Michigan. It will contain 450,000 sq.ft. of floor space and will provide laboratories, classrooms and offices for the divisions of mechanical, civil, electrical and chemical engineering of the Technological Institute, which is a new division of the university, and for the chemistry and physics departments.

For the building being built Holabird and Root, Chicago, are the architects, and R. C. Wieboldt Co., Chicago, the contractors.

Establishment of the Technological Institute at Northwestern to serve the 800 students who will alternate studies with industrial work, was reported in our issue of March 30, 1939, p. 419.

Engineers get overtime pay on defense work

All civilian employees of the War Department paid on a per annum basis will be paid time and one-half for overtime in excess of 40 hours in any work week under the terms of a federal bill passed recently for "strengthening of the national defense."

An earlier naval appropriations bill had provided for overtime pay at not less than one and one-half times the computed hourly rate for engineers, draftsmen and sub-professional employees in the Navy Department. Both bills were sponsored by the Federation of Architects, Engineers, Chemists and Technicians (CIO).

• • •

Connecticut would require town to use sewage plant

The Connecticut State Water Commission has taken steps to force the town of Thompsonville to operate a new sewage treatment plant and interceptor sewer system completed nearly a year ago at a cost of $350,000. The town has refused to operate the plant on the grounds that the system does not serve all sections of the town and that only certain districts would benefit. A hearing is set for July 17 and it is predicted that the matter may reach the courts for settlement.

The plant was constructed with WPA funds.

WASHINGTON HIGHLIGHTS

COMBINATION engineering-construction contracts are likely to be a feature of Army defense construction. Policy to be followed on this is still under discussion among quartermaster corps officials and no decision has been reached. Indications are, however, that consulting engineers will continue to be called in on some jobs, but that in dealing with large contractors having engineering organizations, the Army will just provide a rough sketch and tell the contractor to go ahead. Strictly, of course, this will not constitute competitive bidding for engineering, since the contracts will be let by negotiation on a fixed-fee basis—substantially the same terms on which engineering contracts are usually awarded.

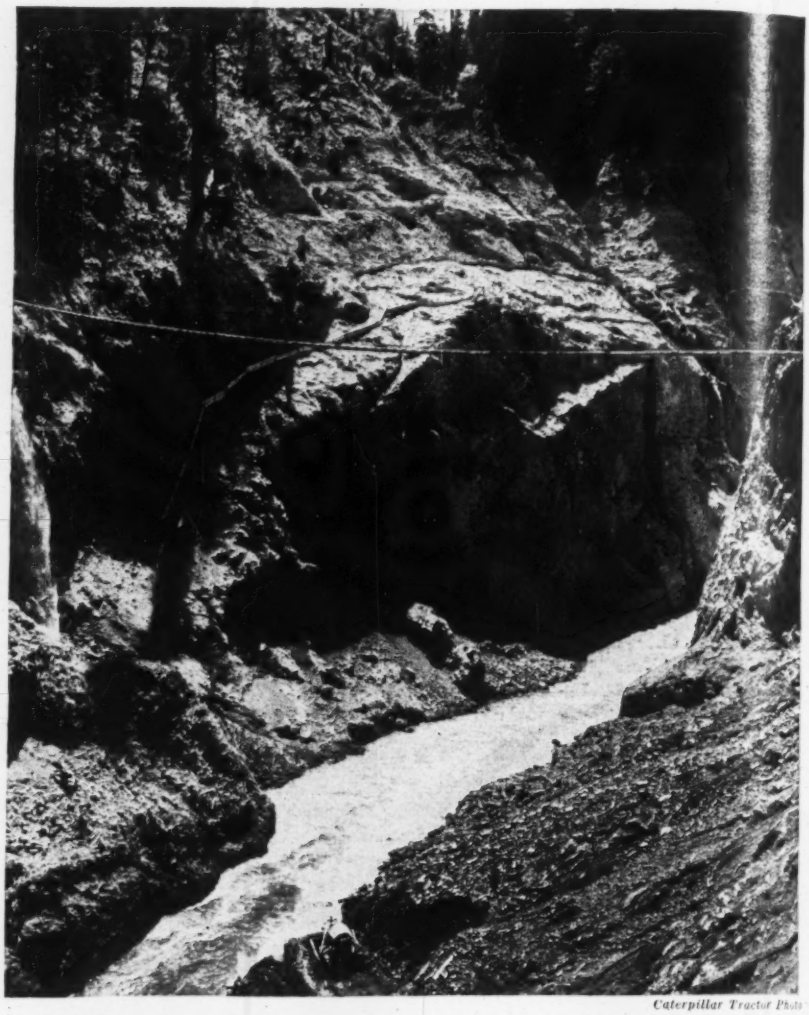
IT'S STILL a mystery where most of the half-billion or more worth of government armament plants will be located, but it's possible to say where they won't be. All the plants will be located within an area bounded by a line 250 miles from the coasts and 200 miles from the land boundary. This area will be broken up into five regions, and the plants will be so scattered that each region will be a more or less self-contained ordnance-production unit.

THE PRESIDENT has signed a bill permitting the Metropolitan Water District of Southern California to lease public lands containing salt deposits for the purpose of extracting the salt. The district needs the salt to use in regenerating the zeolite in the plants with which it softens Colorado River water. Through a technicality in previous law the district was unable to lease public lands that it might need.

CONGRESS has passed and sent to the White House the long-pending bill revising the financial set-up of Boulder Dam. The measure would reduce the rates for power, stabilize the payments to be made to Arizona, Nevada, and the Colorado River Development Fund, liberalize the repayment provisions, and give the government closer control over operation of the generators.

MECHANIZED WAR means other things than tanks and airplanes. The army engineers are getting mechanized too. Army is now buying, for the use of engineer troops, 50 road graders, 45 ½-yd. concrete mixers, and 43 ⅜-yd. power shovels. Buying procedure, under the new powers to negotiate, is to obtain quick informal bids from all the major manufacturers and then to take the lowest bid.

WHEN the President last week asked Congress to add nearly $5,000,000,000 more to the defense appropriations, he included requests for $158,535,000 definitely allocated to construction. In addition, he asked for $178,000,000 to make a start on the immense expansion of the Navy which Congress has decided on, and much of this will go for building and equipping shipyards and armor and gun factories. A further indeterminate amount will be allocated to plant construction from a $325,000,000 fund which the President asked for expediting production of Army needs. The construction money consists of $82,002,000 for construction at Army posts, $36,533,000 for seacoast defenses, and $40,000,000 for Naval public works.



Caterpillar Tractor Photo

Abutment stripping makes progress at Stevens Dam

At this site on the White River near Enumclaw, Wash., 35 miles from Seattle, the highest earthfill dam in the world is under construction, with abutment stripping activity under way. Known as Stevens Dam (formerly Mud Mountain) it is being built by the Guy F. Atkinson Co., San Francisco, for the U. S. Engineers in accordance with a $5,344,000 contract.

The dam whose purpose is flood control will be 425 ft. high, 2,200 ft. wide from upstream to downstream toe and 54 ft. wide at the crest. Its length is comparatively short. During construction, White River will be diverted by a 23-ft. tunnel.

• • •

Niagara Bridge work expected to continue

Although a move to halt construction of the new Rainbow Bridge across the Niagara gorge at Niagara Falls has been made known in order to devote Canada's share of the cost to prosecution of the European war, there is apparently no legal manner by which this can be accomplished, as money for the project, $3,760,000, has already been made avail-

able by the sale of bonds and work begun on both sides of the river.

On the Canadian side, Aikens & McLaughlin of St. Catherines, Ont., contractors holding a $127,000 contract for construction of the Canadian abutment work, have already started placing concrete. On the American side, McLain Construction Co., Buffalo, is expected to start pouring concrete this week.

The Bethlehem Steel Co. has a $1,452,000 contract for the main arch span and Cameron & Phin, Welland, Ont., has the contract for the Canadian approach work. The work is being done by the Niagara Falls Bridge Commission with Edward P. Lupfer Engineering Co., Buffalo, supervising construction, and Waddell & Hardesty, New York, acting as consultants. Aymar Embury, New York City, is architect for the project.

• • •

Placing of concrete begins at Shasta Dam

Placing of the 6,000,000 cu.yd. of concrete required for Shasta Dam on the Sacramento River in California was begun July 8. The project, to be the second largest masonry dam in the world when completed, is being carried out by the Bureau of Reclamation for flood control and power at a cost of $80,000,000.

Pacific Constructors, Inc., are general contractors for the work and Columbia Construction Co., Inc., is the aggregate supply contractor. For the Bureau of Reclamation Ralph Lowry is the construction engineer for the Shasta division and Grant Bloodgood is in charge at the dam. The construction plant layout at this dam was described in *ENR* July 4, 1940, p. 18 and the unusual aggregate processing and supply facilities are covered by an article in this issue.

• • •

Montana too busy for bituminous conference

Don A. McKinnon, chief engineer of the Montana State Highway Department, has announced that he and his engineers are too busy with more than 80 projects to plan another Montana National Bituminous Conference for this year. McKinnon started the conferences six years ago as a meeting for engineers of Montana and neighboring states to discuss practical problems of bituminous highway construction and maintenance. The conference rapidly grew to national size, and for the last three years every state in the union sent delegates. The 1939 meeting was held at Sun Valley, Idaho.

Plans are being made to resume the conference in 1941, presumably in the early fall.

Strike halting construction in Washington settled

Wage-Hour Administrator rules, against legal advice, that dredge workers are seamen

A strike of sand and gravel workers which had halted work for several days on nearly all building construction in Washington — including one building needed to provide defense office space — was settled last week when the Wage-Hour Administration decided that dredge workers are seamen. The decision, reversing a long-standing ruling of the wage-hour administration, was made personally by Administrator Philip B. Fleming, against the advice of his legal department.

Wage increase idea turned down

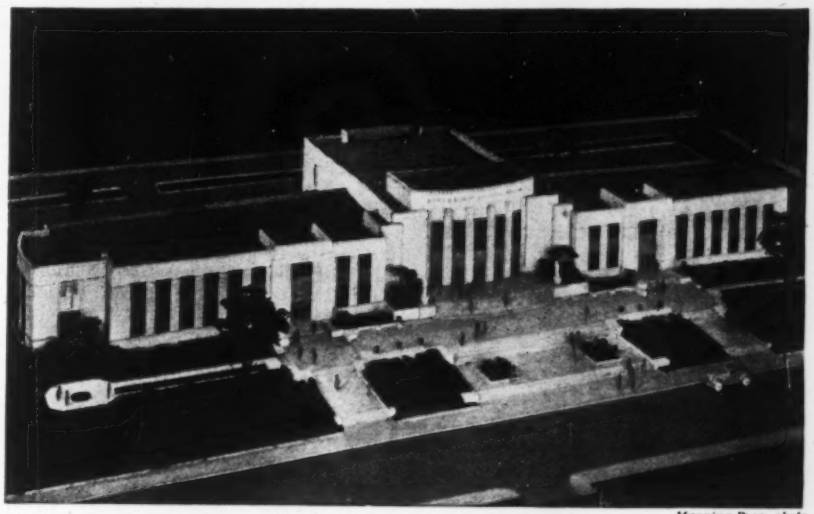
The Smoot Sand and Gravel Co., which furnishes substantially all the concrete aggregate used in the Washington area, has been working its men 58 hours a week on the theory that they are seamen and therefore exempt from the wage-hour law. Some weeks ago the wage-hour administration informed the company that dredge workers have been ruled not to be seamen and that the company was violating the law. It was suggested that if the company would pay 10 per cent more wages, it could continue its existing schedule, since this would cover time and a half for overtime.

The company, however, reduced hours to 42 a week, and the men went on strike, demanding that the 10 per cent plan be adopted. Last Friday, Administrator Fleming announced his changed decision, and the 58 hour week was resumed.

Col. Fleming's action occasioned considerable surprise, since the President the same day released, with expressions of approval, a letter from Fleming in which the Colonel argued that there is no need to extend the 42-hour week for defense production and that, in fact, such an increase would probably reduce production.

Monopoly inquiry being studied

At the request of Federal Works Administrator Carmody, the Department of Justice is now investigating whether Smoot's near-monopoly of gravel in the District of Columbia violates the anti-trust law.



Manning Bros. photo

Detroit Engineering Society to get new headquarters

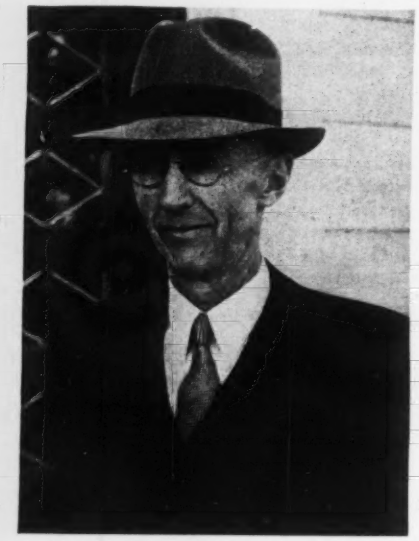
The Horace H. Rackham Educational Memorial Building, which is being built for the Engineering Society of Detroit and the University of Michigan, became a construction project July 1 with ground-breaking ceremonies. Shown above is a photograph of the model of the $1,500,000 building, which is to be the permanent headquarters of the Detroit society and the extension service of the University of Michigan. The center portion of the building will be a large auditorium; one wing will be occupied by the university extension service, and the other wing will be given over to quarters for the 5,500 members of the engineering society.

The structure will be over 500 ft. long and vary in depth from 150 ft. at the center to 65 ft. at the ends. The work is being done by the W. E. Wood Co., Detroit, with Frank Austin representing the contractors on the job and E. R. Martin the owners. Harley & Ellington, Detroit, are architects and engineers.

Harper named chief reclamation engineer

Sinclair O. Harper, assistant chief engineer of the Bureau of Reclamation since 1930, has been appointed chief engineer to succeed the late R. F. Walter. Harper, who will be stationed at Denver, becomes the fifth chief engineer of the bureau.

Since his graduation in 1907 from the University of California, Harper's entire professional life has been spent with



Sinclair O. Harper

the bureau. After a few months as junior engineer at Uncompagre, he became assistant engineer on the Grand Valley project in Colorado, spending the next eight years on that project being in charge of operations the last eight years. In 1925 he was made general superintendent of all reclamation construction and five years later his title was changed to that of assistant chief engineer. Harper is now 57 years old.

• • •

Harrison put in charge of defense construction

W. H. Harrison, vice president and chief engineer of the American Telephone and Telegraph Co., has been appointed Director of the Construction Division of the National Defense Advisory Commission by William S. Knudson, member of the commission in charge of production problems. Harrison, an electrical engineer and past president of American Institute of Electrical Engineers, came up through the engineering side of A. T. and T. and was for some years in charge of building for that company.

Harrison sees his job as being, broadly, to insure that the construction side of defense moves forward smoothly while at the same time there is the minimum disturbance of normal work. This is not a difficult assignment for the present, he thinks, because the industry can easily absorb without dislocation the amount of work so far demanded of it; but as the program grows, it will be Harrison's responsibility to allocate work so that one contractor is not assigned more work by different agencies than he can handle. If shortages of material develop, Harrison will have to do something about it, and he will have to watch for labor difficulties shortages, and troubles with transportation. He will keep in touch not only with government construction but also with private work of a defense nature, such as plant construction and housing for defense workers.

Although the detailed machinery by which he will keep his finger on this broad field has not yet been worked out, it has already been decided that all major contracts will clear through his office. How early in negotiations Harrison will come into the picture is still an open question. The immediate job on which Harrison is engaged is a survey of the problem to find out what the defense program will demand of the construction industry and, in a general way, what facilities the industry has available to meet the demand. On this latter phase, he is working closely with the defense committee set up by the industry some months ago. The committee has already laid the groundwork for this study.

Albert Kahn makes employees part owners

In recognition of nearly 25 years of service of each of 27 employees, Albert Kahn, Inc., Detroit, Mich., has been reorganized under the firm name of Albert Kahn Associated Architects and Engineers, Inc., all 27 members being stockholders. The old firm will complete the work it now has under contract, but all future jobs will be undertaken by the new corporation.

Large Baltimore paving and sewer fund sought

Mayor Jackson of Baltimore plans to ask the voters of that city to approve in the November elections a $5,000,000 sewer loan and an equal loan for paving work. He has not made known details as to how the money will be spent.

JOBS OF THE WEEK

NAVAL BASE CONSTRUCTION, U. S. and Foreign Possessions

Eleven projects totaling some $125,000,000 as detailed on p. 35.

JOHN MARTIN DAM, Caddoa, Colo.

W. E. Callahan Construction Co., Gunther & Shirley Co. and Roln-Connolly Co., Los Angeles submitted combined low bid for John Martin Dam (formerly Caddoa Dam) to U. S. Engineers, Caddoa, Colo., $7,160,754. Engineer's estimate $6,541,058. John Martin Dam, to consist of a 1,140-ft. concrete overflow section, a 4,000-ft. earth embankment, and two long earth dikes, will be built on the Arkansas River in southeastern Colorado below village of Caddoa. Capt. James H. Stratton, district engineer at Caddoa, will be in charge.

HANGARS, Chicopee Falls, Mass.

Tuller Construction Co., Red Bank, N. J., low bidder for four 238x272 ft. hangars and a 272x340 ft. hangar and shop at Northwest Air Base, $1,623,300. Bids taken by Constructing Quartermaster Westover Field.

APPRAISERS STORES and IMMIGRATION STATION, San Francisco, Calif.

Clifton Construction Co. of California, San Francisco, will build 14-story, reinforced concrete appraisers stores and immigration station for Public Buildings Administration, Washington, D. C., $3,771,000. Bids were taken on this job Dec. 15, with the above contractor lowest bidder, but bids were larger than money available.

TRACK RELOCATION, State of Washington

J. A. Terteling & Sons, Boise, Idaho, will relocate Great Northern Ry tracks from Kettle Falls to Williams and from Kettle Falls to Boyd, $1,037,237. Project includes earthwork and structures for adjacent highway relocations in Columbia River Reservoir for Columbia Basin Project. Bureau of Reclamation, Coulee Dam, Wash. awarded contract.

NOTE—Additional bidding and contract news on over 600 projects, large and small, appears in the Construction News Section beginning on page 119.

Defense housing needed authorities report

Warn of defense program bogging down unless housing is made available soon

Warning of a possible danger that "the entire defense program will bog down" unless housing accommodations are built immediately for thousands of workers in key industrial cities was sounded this week by the National Executive Committee of Housing Authorities whose personnel consists of the chairmen of seven municipal housing authorities. In a review of existing housing conditions, based on reports sent in from all over the country, the committee pointed out to Nathan Straus, USHA administrator, that "with building activities curtailed in recent years and with almost no surplus dwellings today, we cannot possibly provide for the workers in the defense industries and the families of enlisted men assigned to expanding Army and Naval bases. The situation is far worse than during World War years when there was some cushion of vacancies to absorb increased activities."

The committee recommended that action should be taken at once on Senate Bill 591, which has passed the Senate and is now pending in the House, to make funds available to USHA to start defense housing projects; that national defense orders be placed only where housing can be made available; that local housing authorities should extend the facilities of housing projects now under construction to include, where possible, families of defense workers; that local housing authorities should select vacant or nearly vacant sites which can be purchased immediately and should select types of construction for defense housing which are faster built than ordinary types.

The committee also recomends that defense housing should be permanent in character wherever feasible and that it should be located where there is a probability of its being used after the emergency. It favors use of the local authorities rather than having USHA embark on the direct construction of projects, although it grants that USHA should undertake direct construction where there is no existing local authority which is able to operate effectively. Finally the committee recommends that public housing projects for slum dwellers should not be interrupted.

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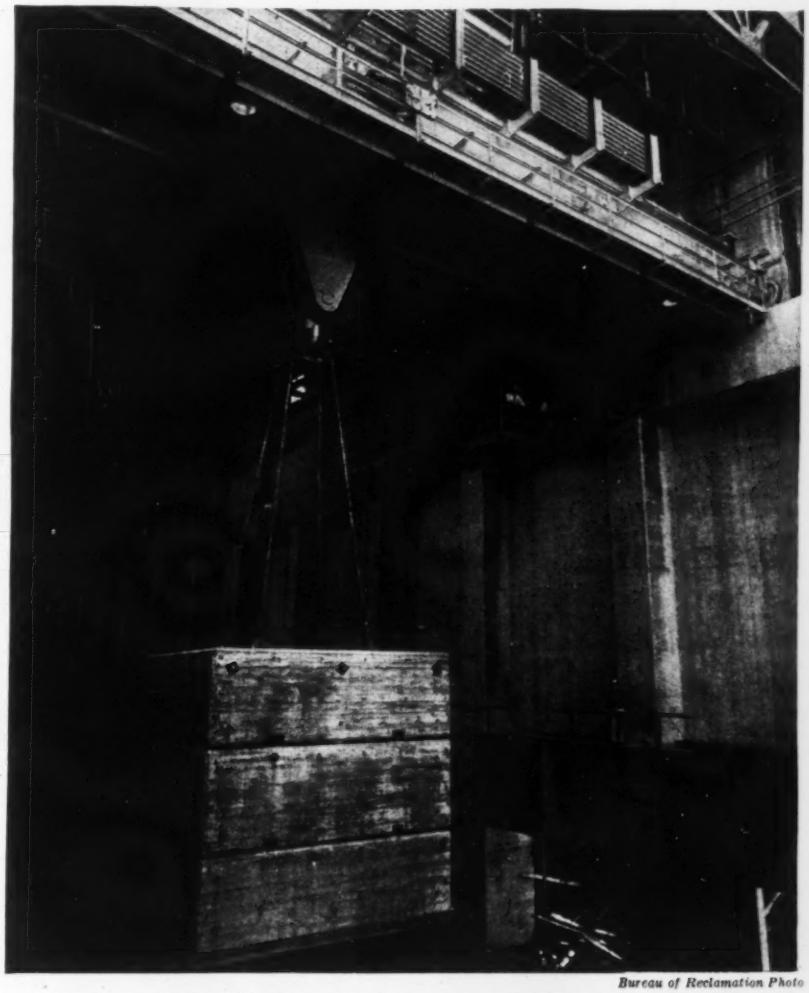
Six grouting tunnels planned at Shasta Dam

In the rock underlying the abutments of Shasta Dam, now under construction on the Sacramento River in California by the Bureau of Reclamation, six tunnels are to be driven, on a slight upgrade, for inspecting the formation and for later use in grouting fissures or fractured zones.

Tunnels already driven are 500 to 600 ft. long; others are to be put in when excavation is further along. After these tunnels have served their original purpose for inspection, they are to be lined with concrete and will be kept open permanently.

Wherever seams or crushed zones, indicating movement, are exposed on the bedrock surface as excavation progresses, these are trenched out. At points where bed rock extends down some distance shafts are sunk into the rock to be filled with concrete when the dam is poured.



Bureau of Reclamation Photo

Hook of Grand Coulee Dam crane lifts a test load

Rated for a capacity of 175 tons, the hook of one of two large cranes in the west power house at Grand Coulee Dam was recently tested with a 219-ton block of concrete. When they are working in tandem the two big cranes can lift a total load of 700-tons. They will soon be called on to install the 625-ton rotors for Grand Coulee's large generators.

Court refuses to open Chicago sludge case

Holding new evidence irrelevant, incompetent and not intentionally false in the activated sludge patent infringement suit originally won by Activated Sludge, Inc., Walter C. Lindley, federal district judge at Danville, Ill., has entered an order refusing to reopen the case.

The Sanitary District of Chicago sought to reopen the case, the decision having been upheld by the U. S. Supreme Court. The new evidence questioned the ownership of the patents.

The case has been in the courts for many years and was decided in favor of activated sludge in 1937. Additional details of the court litigation are given in *ENR*, Oct. 26, 1939, p. 519.

Illinois contractor fined for false PWA report

Ira M. Dudley, excavation contractor of Springfield, Ill., has been fined $250 by the federal court at Springfield for making false claims to the federal government concerning wage scales paid in 1938 on a PWA project at the state fair grounds. Dudley pleaded guilty.

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Texas housing law upheld by court

The Supreme Court of Texas has upheld the validity and constitutionality of the Texas Housing Authority law, which permits Texas communities to participate in the slum clearance and low rent public housing programs of the USHA. This makes a total of 25 states where the highest state tribunals have upheld local public housing programs assisted by the USHA.

OBITUARY

ALVAH H. SABIN, 89, long a leading figure in the field of metal paints and for many years prior to his retirement in 1937 consulting engineer to the National Lead Co., died July 11 in New York City. A native of New York, Sabin was professor of chemistry at Ripon College in the 70's and later taught at the University of Vermont and New York University, and served as state chemist of Vermont for four years. In 1883 he invented a process for producing sugar of milk, and for several years was active in this industry. In 1887 he operated a mine and mill producing iron oxide pigment, and in 1888 he entered paint manufacture as chemist and chemical engineer of Edward Smith & Co. He developed the bituminous coating used on the first Rochester water conduit and the "cable shield" compound with which the Williamsburgh Bridge cables were filled, and contributed to the improvement of red lead and its commercial production in paste form.

CHARLES A. ALLIN, 73, California pioneer and civil engineering partner of Thomas D. Allin, city commissioner of Pasadena, Calif., died in that city July 3.

MINAR R. ROSMAN, 55, a graduate of Beloit College, Beloit, Wis. and Milwaukee builder, died in Milwaukee July 7. Rosman was in the building business for some time with Robert A. Smith under the firm name of Rosman & Smith and from 1919 to 1930 he was doing the same type of work in partnership with Oliver Wiersdma.

WILLIAM A. O'BRIEN, contractor of Butte, Mont. who built some of the buildings of the Montana School of Mines, died recently at Butte.

WILLIAM STONE POST, 74, retired partner of the old New York architectural firm of George B. Post & Sons, died in Bernardsville, N. J., July 8. Post, a graduate of Columbia University, retired in 1930 after designing many important buildings in New York City, the Statler Hotels in Cleveland, Detroit, St. Louis, Boston and Buffalo, and the Wisconsin State Capitol.

AUGUST F. ERBACHER, 63, head of the Interstate Construction Co., Kansas City, Mo., died recently in that city. Erbacher was a former vice president of the Associated General Contractors of America.

STORRS M. BISHOP, 65, former New York State Barge Canal engineer and commissioner of public works in 1918-19 at Schenectady, N. Y., died early this month at Schenectady, N. Y. Bishop, a graduate of Lafayette, supervised construction of locks and dams on the Monongahela River in Pennsylvania.

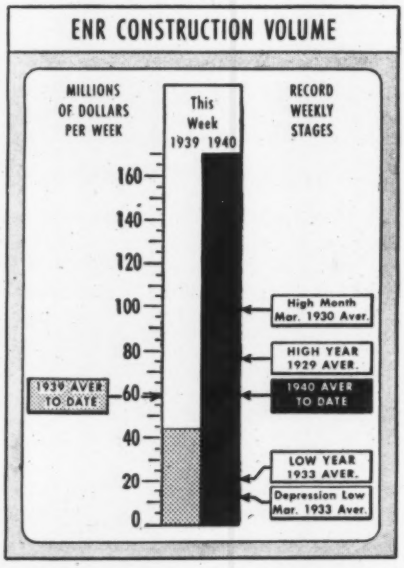
CONTRACTS AND CAPITAL

ENGINEERING CONSTRUCTION awards for this week at $170,834,000 exceeded the corresponding week last year by 290 per cent and the preceding record week this year by 74 per cent. Private construction is 5 per cent below a year ago and 59 per cent below a week ago, while public construction shows a gain of 440 per cent over last year and 145 per cent over last week.

The current week's construction brings the 1940 volume to $1,690,088,000, .73 per cent below that of a year ago. Private awards for the 29-week period at $540,042,000 are 22 per cent above a year ago, while public construction at $1,150,046,000 is 10 per cent lower. Federal awards for this period total $277,577,000 a gain of 122 per cent.

Unclassified construction at $80,265,000 reached its highest volume since February 4, 1937 while public buildings at $58,168,000 exceeded the previous high week of January 12, 1939. Subtotals for the week in the other classes of construction are: waterworks, $2,265,000; sewerage, $1,712,000; bridges, $2,948,000; streets and roads, $13,338,000; earthwork and drainage, $3,303,000; commercial buildings, $4,666,000; industrial buildings, $4,169,000.

New capital for construction for the week totals $55,841,000. This includes $5,816,000 in state and municipal bonds, $51,000,000 in short-term-municipal notes for USHA housing and $25,000 in RFC loans for public improvements. This brings the total for the 29-week period to $1,667,125,000, 4.3 per cent below a year ago.



CONTRACTS

(Thousands of dollars)

	Week Ending July 20 1939	July 11 1940	July 13 1940
Federal	$1,875	$28,822	$130,736
State & Municipal	27,240	35,205	26,276
Total public	$29,115	$64,027	$156,941
Total private	14,668	34,012	13,893
TOTALS	$43,783	$98,039	$170,834
Cumulative			
1940 (29 weeks)			$1,690,088
1939 (29 weeks)			$1,702,759

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works, $25,000; industrial building, $40,000; other buildings, $150,000.

NEW PRODUCTIVE CAPITAL

	1939 29 Wks.	Cumulative 1940 29 Wks.
NON-FEDERAL	$928,566	$893,603
Corp. Securities	134,355	92,225
State & Mun.	370,641	525,164
R.E.A. loans	83,732	...
U.S.H.A. loans	146,419	87,204
R. F. C. loans	3,419	7,010
[1]Fed. Aid-Hwy.	3,419	7,000
FEDERAL	190,090	184,000
Total Capital	$1,750,093	$1,677,173

FHA MORTGAGES

	Week Ending July 13 1939	July 6 1940	July 13 1940
Selected for appraisal	$22,479	$22,175	$27,883*
Cumulative			
1940 (28 weeks)			$685,795*
1939 (28 weeks)			$639,160

* Subject to revision.

ENR INDEX NUMBERS

Index Base = 100		1913	1926
Construction Cost	July '40	242.15	116.40
Building Cost	July '40	291.68	109.02
Volume	June '40	225.	99

COMMENT AND DISCUSSION

Readers' opinions on matters that concern engineers and contractors

Orchids for Our News

Sir: I always believe in giving my friends their orchids while they are living and can enjoy them, so I wish to take a few minutes out to tell you how much we appreciate the very fine job of reporting which you have been doing.

We particularly appreciate your Washington news stories on national defense, W.P.A. and other construction legislative matters, as well as your editorial interpretations of these subjects.

Your ability to give us this news accurately and quickly seems to be equivalent to the performance of our best general weekly news magazines, and in a trade publication that is something unusual.

I want you to know that *Engineering News-Record* is read the minute it reaches our office, and I do not see how any active construction executive could get along without it.

F. J. CONNOLLY
Manager
Southern California Chapter
Associated General Contractors of America

From a Letter to Architects

Sirs: If you are mentally constituted as I am, most highbrow reports of tests as conducted in the various laboratories interest you very little, until put in good usable form for the practical designer. I skim over such reports when they come to my notice, paying particular attention to the conclusions and the source of the reports, but if they are obviously laboratory material, with little application to field or office use, I pay little attention to them. Occasionally, however, something hits me as being particularly usable.

A most interesting report of the sub-committee on wind bracing was submitted to a recent meeting of the American Society of Civil Engineers. This report is summarized in *Engineering News-Record*, Feb. 1, 1940, p. 63, from which I have picked this single fact as being of interest to all of us. Tests indicate that a roof slope of 30 deg. is not subject to either wind pressure or suction. Below this slope, the suction increases rapidly to a maximum of 12 lb. per sq. ft. at a slope of 20 deg. and remains at 12 lb. on slopes down to a level roof. Above 30 deg., the pressure increases until a roof of 60 deg. slope is subjected to a direct pressure of 9 lb. per sq. ft.

This has a very interesting bearing on the stability of light constructed fairly flat roofs. There are practically no wood roofs or metal decks which weigh 12 lb. per sq. ft. Therefore, unless the roof is thoroughly and positively anchored to the masonry, we must expect to have an occasional flat roof peel off in a good windstorm. Since corrugated metal roofs are usually placed at a slope of approximately 30 deg., we need have less worry about this type of building than about the supposedly better constructed flat roof building types.

Carrying this thought a little further, what constitutes a proper positive anchorage for a light, flat roof? Certainly ordinary nailing of roof boards to joists or rafters is sufficient to make them act together, but how are rafters anchored? Occasionally they are merely laid over steel beams or set on top of the wall on which they bear. And with respect to metal decks, is the ordinary little strap anchor at the edge of each sheet sufficient to guarantee against uplift?

THOMAS H. MCKAIG
Consulting Architectural Engineer
Buffalo, N. Y.

Earthquake Design

Sir: It is interesting to read (*ENR*, June 20, 1940, p. 837) that buildings and water towers designed for horizontal forces 0.08 and 0.10 *g*, static analysis, gave wholly satisfactory performance in the Imperial Valley earthquake of May 18, 1940.

Such design proceeds under the assumption that sustained forces of the above magnitude may be applied horizontally and in any direction at the base of structures and are resisted by equal forces distributed throughout the superstructures. Relatively simple mathematics are entailed by this assumption.

That the applied forces are sustained and continuous is manifestly untrue and it is the contention of the advocates of "dynamic" loading that recognition should be given to the jerky jolting nature of the earth movements. Perhaps in the case of certain buildings wherein there is an appreciable interval between the application of the forces to the foundations and their effects being felt at the roof there is warrant for a "dynamic" analysis with its additional assumptions and more involved and more spectacular mathematics. However, considering the extent of our ignorance about earthquake loadings, to give credit to the damping effect of special structure—when it is known to exist—by static analysis with reduced *g* coefficients is probably sufficiently accurate for all practical purposes.

Earthquake loading consists of the application to a structure's foundations of a chaotic series of unknown loads acting for unknown time periods in unknown directions. It is, therefore, plain that no gain is to result from mere refinement of the mathematics of stress analysis. There is no use in being rigorous in spots—in guessing at loads and then having an agony of exactitude thereafter. The thing to do is to discover the features and characteristics of structures which behave satisfactorily in earthquakes—find out what works—and to incorporate those features in future design. This is but model analysis, with full scale models under actual working conditions.

The late Prof. Suyehiro stated that the fact buildings designed under "the 0.10 *g* basis" resisted the 1923 Tokyo earthquake fairly well was "a datum more valuable than any other arguments." It is again a fact of outstanding significance in this Imperial Valley earthquake that the structures designed for 0.08 and 0.10 *g*, static analysis, sustained no damage. They were not large buildings which were involved, but they are to be compared with other buildings which were not large.

HOMER M. HADLEY
Regional Structural Engineer
Portland Cement Association
Seattle, Wash.

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F. E. Schmitt *and* Waldo G. Bowman, *Editors*

Van Tuyl Boughton, *Managing Editor*

New York: E. J. Cleary, A. N. Carter, H. W. Hunt

Chicago: W. W. DeBerard, Harold W. Richardson

San Francisco: N. A. Bowers

Editorial Offices at 330 West 42nd Street, New York

July 18, 1940

HISTORY was made this week when the volume of heavy construction contracts awarded reached the unprecedented total of $217,000,000, with Army and Navy construction accounting for over three-quarters of the sum. The figures speak for themselves. Another era of great construction undertakings suddenly opens before us, unfortunately minus the elation that would attend the prospect of spending an equal amount of money for works with a more peaceful purpose. Satisfaction must be gained from the thought that by these expenditures we are protecting our segment of the world from the crumbling that has overtaken lands beyond the seas.

Welding Model

MANY OF THE GAINS that can be realized through structural welding are prominent in the new Air Lines Terminal building, discussed by LaMotte Grover this week. The complicated plan of the structure together with local conditions presented requirements that could be met most effectively by welding; the result was ready connection to existing steelwork, reduction of dead weight, compactness, and cost economy. The incidental advantage of noise reduction probably counted little in the traffic din of midtown New York. It had real importance, however, at the Jersey City Medical Center, where a 16-story hospital pavilion and a 23-story nurses' home with welded framework were recently built. When taken together with the Terminal these structures strongly emphasize some of the advantages of welding in building construction. In addition the Air Lines Terminal, with its complex framing and effective details, stands out as a model of welded design.

Avoiding Stress Concentrations

ANOTHER WELDING ACHIEVEMENT recorded in this issue is the successful completion of the welded rigid-frame spans in the approaches to the Maine Ave. Bridge in Cleveland. More like the bold European designs than anything yet attempted in this country, they take full account of the lessons learned in the failures of some of their foreign predecessors. And in the rigid transition joints between girders and supporting columns, Fred L. Plummer, the designer, has given European engineers a detail that may afford an answer to their difficulties with "brittle metal" failure. By using three web plates in this transition section, instead of the usual single one, a degree of flexibility is introduced that, it is believed, overcomes any tendency to "brittle metal" failure that might be caused where intersecting welds (of flange and stiffener, for example) might create biaxial or triaxial stresses. The subject of residual stress concentrations is a vital one in welded structures, but all experience points to a solution in proper detailing and proper weld sequence in shop and field assembly. The Cleveland bridges will afford a full-scale trial of a design that has attempted to bring to bear all available knowledge and a high degree of scientific ingenuity.

Service Knowledge

CURRENT ADDITIONS to knowledge of materials of construction as reflected in the proceedings of the American Society for Testing Materials bring out the fact that progress is not confined to new materials but extends to those known and used for generations—brick, mortar, steel and the like. Evidently even the oldest materials are not yet fully explored, and research plus field experience may be expected to tell us more of how they can best be adapted to working conditions. It is significant that much of the recent advance has been derived from service observation and from associated tests and experiments. The same sources should provide a large part of the future gain in knowledge. Every large construction undertaking is a potential laboratory to improve our knowledge of materials. The increased mastery of materials so obtained will lead to better, safer and cheaper construction.

Clashing Objectives in Housing

IN THE GOVERNMENT'S kaleidoscopic movements over the defense front nothing has been touched upon so lightly as housing. And the one definite development which has been recorded raises some puzzling questions. This development is the authority granted by Congress in amend-

ments to the recent naval expansion bill for the USHA to take the lead in defense housing. The grounds for the supposition that USHA is ideally fitted to build emergency housing are by no means clear. The USHA is a financial agency, not a builder or a planner. Through the local housing authorities, to which it lends funds and gives subsidies, it can bring to bear a considerable designing and supervisory personnel in the field of housing, but these local authorities think in terms of social housing, of long-time planning, of slum removal. None of these elements is involved in the housing that will soon be needed. Given the job of defense housing, a local authority will immediately face a clashing of objectives. It is at least possible that efficiency in building defense housing will thereby suffer, and that after the emergency the authority will be left with housing for which there is no need. No doubt the USHA has a proper place in the defense housing plan, but to put it in the dominant position, without more study of what other agencies are available to help, is not reassuring for the future.

Water and War

THE REPORT on sabotage and water service, published on p. 50 of this issue, emphasizes some of the precautions that waterworks officials have cause to consider. There is of course no cause for hysteria. We are not at war, and our industrial preparedness effort is not an immediate enough threat to any country to warrant as yet any concerted plan to cripple it. But preparedness in water supply requires thinking and planning ahead, just as does preparedness in manufacture of guns and powder.

Several weeks ago, when the field survey upon which the report is based was made, there was a wide difference in attitude among waterworks officials on the danger from sabotage. Some were completely unconcerned. Others, admitting that they had overlooked the matter, were eager to get suggestions so that immediate action could be taken. But only in a few places was it found that precautionary measures were planned or in action; there, be it said, however, characteristic thoroughness and foresight were plainly in evidence.

This is not a reassuring situation at a time when every effort should be taken to expedite the nation-wide preparedness program. Water supply is a fundamental resource in industrial processing and for fire protection. Any interruption to this vital service at key industrial centers could paralyze production and demoralize community spirit.

The waterworks profession, which has always distinguished itself in the service it renders, now faces the challenge of even greater responsibilities. Adoption of sensible safeguards would seem to be an aid in discharging these responsibilities.

Better Public Works

PUBLIC-WORKS CONSTRUCTION by the national government stands to gain in usefulness and efficiency by coordinated planning, programming and budgeting, which the President's recent executive order (*ENR*, July 11, 1940, p. 59) sets up. Such coordination has been lacking up to now. The dozens of federal bureaus that plan and build public works have functioned to a large extent in watertight compartments, with constant risk of conflict or misfit. Urgent improvements often had to wait on projects of remote value. When the new system gets into full operation this haphazard process should give way to order and coordination.

Because the national government is the world's biggest builder, its construction operations affect the construction industry and our economic life profoundly. Public-works efficiency or the opposite, therefore, reacts on every business and every individual—through taxation, material or labor effects, enterprise policy, and the stimulation of development by the works themselves.

Nearly a decade ago the important relation of public works to the national wellbeing received the attention of Congress, and the Federal Employment Stabilization law was enacted in 1931 to provide for advance programming of federal works. But so long as this programming was mere compilation of uncoordinated bureau plans it could not become effective. Bringing the bureaus into real cooperation through the joint action of the National Resources Planning Board and the Bureau of the Budget under the executive order accomplishes a decisive improvement and will tend to develop our resources in logical sequence.

There is nothing new or radical in the procedure established by the order. Simply viewed, the system merely applies business method to government. No large corporation could prosper if it did not coordinate the expansion and construction plans of its individual departments with regard to the best development of the organization as a whole. When the public business follows the same course everyone will profit.

Moorings for Lake Washington Bridge

Contents in Brief—The concrete pontoon bridge that crosses Lake Washington at Seattle is held in place by steel cables, two of which extend at right angles from each of the standard pontoons to anchors on the lake bottom. A total of 64 anchor lines secure the floating structure transversely and horizontally. All cables slope at about 22 deg. with the horizontal and are set with varying tensions depending on the cable length. Tension will have to be adjusted in the shorter cables for fluctuations of lake level which may reach 3 ft.

CABLE ANCHORAGES for the concrete pontoons of the floating bridge across Lake Washington at Seattle have presented some novel problems, notably in provisions for jacking to maintain desired tension and in fastenings that transfer stress from steel cable to pontoon. The anchors themselves as well as the fastenings between adjacent pontoons are parts of a carefully developed plan to secure maximum rigidity while making provisions for adjustments that will be necessary as the level of the water surface fluctuates.

The Lake Washington Bridge was completed on schedule and opened to traffic on July 2. This project comprises six and one-half miles of new highway, including a twin tunnel 1,445 ft. long, several bridges or overpasses and the pontoon bridge, which provides a short approach to Seattle. Previously published articles relative to this bridge appear in *Engineering News-Record*, Aug. 3, 1939, p. 144, Oct. 5, 1939, p. 440, and Feb. 1, 1940, p. 162.

The typical pontoon (59x350 ft.) has 96 cells, mostly 14-ft. cubicles, making up 12 watertight compartments each accessible from the deck for inspection and pumping out if necessary. Including specials at the draw span, there is a total of 25 pontoons. Joints between them are made with concrete shear keys and bolts with upset threads. In this standard connection there are thirty-eight 3¼-in. and sixteen 2¾-in. bolts with upset ends. The joints are finally grouted to make the entire floating assembly on either side of the draw a single rigid structure.

The 378-ft. floating draw span will give a clear channel opening 200 ft. wide. It will be opened by telescoping into the adjacent fixed pontoon, which is built on a Y-plan, the road splitting and following the fork of the Y around the opening. Electric power is provided to complete an opening in 1½ min.

The 7,721-ft. shore-to-shore length of the pontoon structure spans water whose depth ranges up to 220 ft., and much of the route is over soft bottom.

From mid-length of each pontoon one cable goes out on either side, at right angles to the bridge center line, to an anchor on the lake bottom. Three types of anchors are used (Fig. 3), suited to the different kinds of bottom. Type A is for soft bottom where it is feasible to get the anchor imbedded. A total of 41 are in use on mud, sand or soft clay bottom.

Type B consists of a 13x26x20-ft. concrete box which is lowered to the bottom, filled with rock and prevented from being pulled toward the bridge by 900 cu.yd. of dumped quarry run rock. Four anchors of this type, designed for hard clay bottom, are in use.

Type C anchors are for shallow water where the bottom is too hard for type A. Of these, 19 are in use on medium-hard clay bottom. The piles are 14x24-WF steel beams, driven under water with a drop hammer to penetrations of 13 to 16 ft.

A visitor to the job at the time the bridge was under construction would have seen anchors of the A and B types being brought on barges to buoys marking the exact locations. Before the anchor is lowered by a floating derrick, an eyebar is attached and at its outer end the cable is fastened. On type A anchors final operations before they go down include the

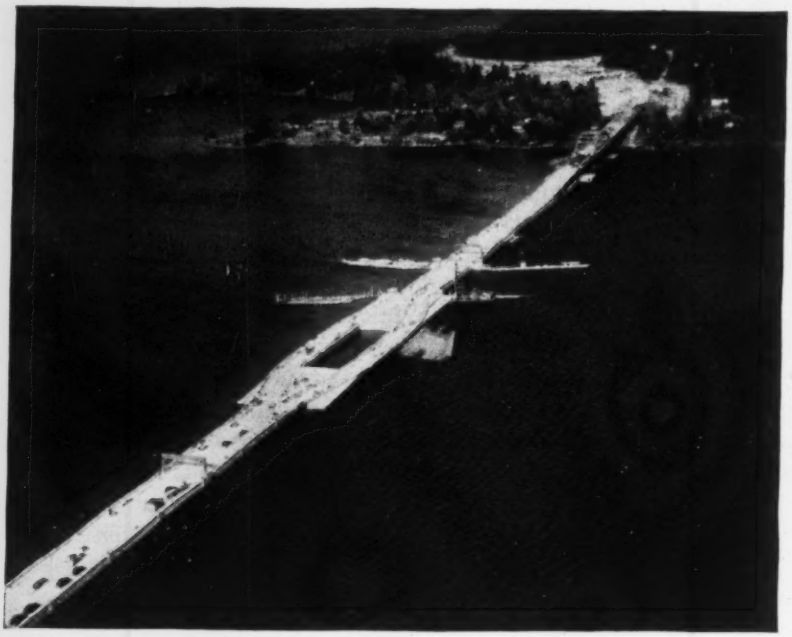


Fig. 1. The Lake Washington pontoon bridge as it looks from the air.

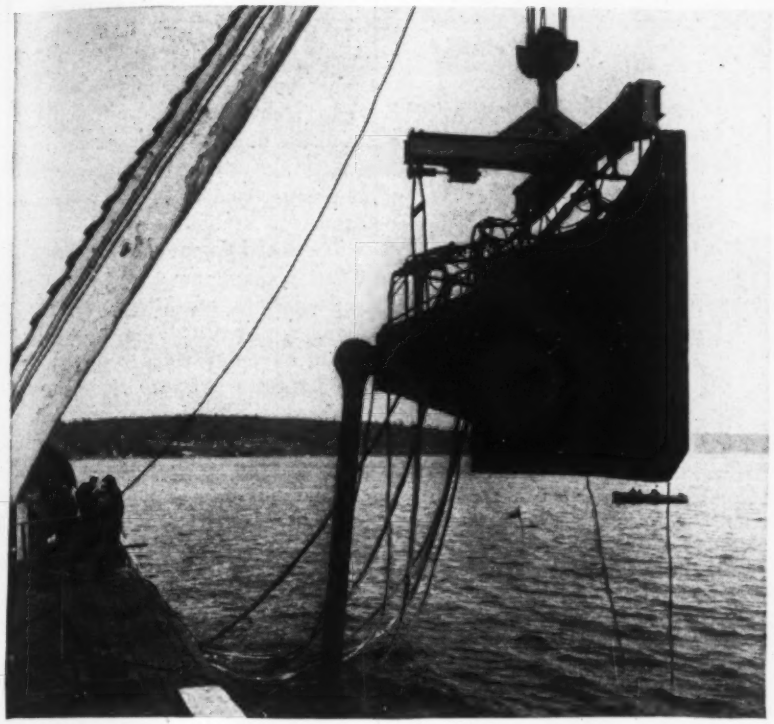


Fig. 2. Lowering 65 ton, type A anchors that maintain alignment of pontoons.

attaching of jet hoses, air lines and a bridle running to an anchor about 1,000 ft. farther away from the bridge; the bridle is used to orient the anchor position just prior to landing it on the bottom. Also, a measuring wire is connected to the eyebar with its zero point corresponding to the end of the cable, thus permitting direct measurement of actual cable length to be made after the anchor is set. The type A anchors are lowered with the aid of a spider hooked into lifting ears cast into the concrete (*ENR*, Aug. 31, 1939, p. 265).

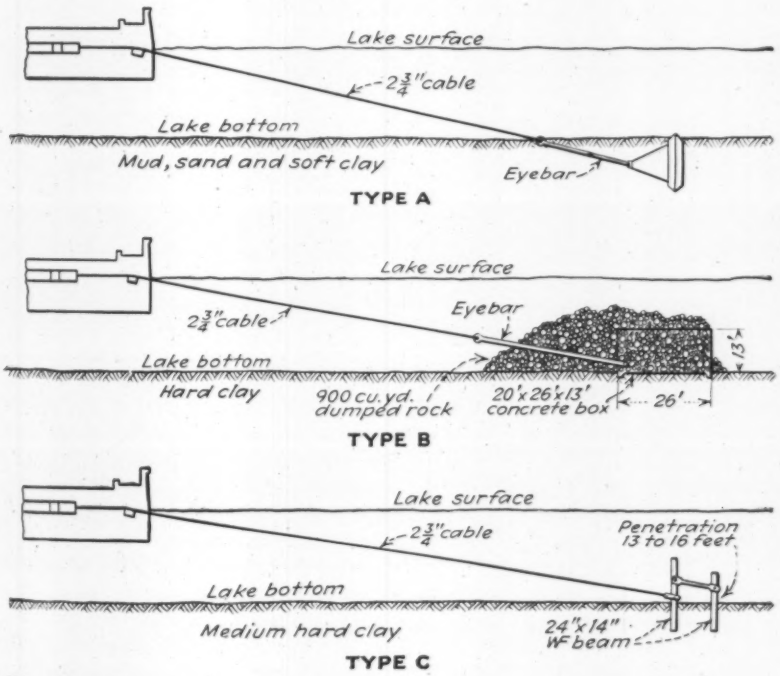


Fig. 3. Anchors of three types as shown are suited to three kinds of bottom.

When the anchor is within 5 ft. of the bottom, a diver goes down to make sure that the eyebar is not in the mud and that all lines are clear. The anchor is then plumbed and oriented into a position at right angles to the bridge. The dead weight of 65 tons is aided by the water jets in sinking the anchor as far into the mud as possible. Jetting time varied, depending upon hardness of the bottom, from 5 min. to 8 hr. 55 min.

As each pontoon is towed into position, a derrick barge is anchored 30 ft. north or south, depending on wind direction, of the bridge center line and opposite the midlength point of the pontoon. From this position the pontoon can be held on line by the derrick barge preparatory to making permanent fastenings.

When a pontoon is brought into position adjoining the one last anchored, if adjustment is necessary water ballast is pumped in by small portable pumps until the pontoon settles to a level that permits the two concrete shear keys in the adjoining pontoon faces to engage. These keys are 3 ft. square and project 12 in. to fit corresponding recesses in the end of the adjacent pontoon. (Final adjustment for line and grade between pontoons is accomplished by driving steel shims in the spaces between shear keys and the openings into which they project.)

The measuring wire that was attached to the anchor before lowering is raised from the lake bottom and pulled through the cable port in the side of the pontoon. With a spring scale a tension of 106 lb. is put on this measuring wire, thus producing the same sag in the wire as the anchor cable will assume under load. With the required length thus determined and as exact cable lengths have previously been marked at intervals, the cable can then be cut and socketed at the proper length. The sockets are poured on the derrick barge where they are allowed to cool several hours before being placed in the water and passed through the cable port in the side of the pontoon.

The socketed cable end is pulled into position in the pontoon by a line from the hoisting engine on the floating derrick. This line is passed through a hatch in the pontoon deck around a temporary sheave and out through the port to the cable end. The cable can then be pulled in

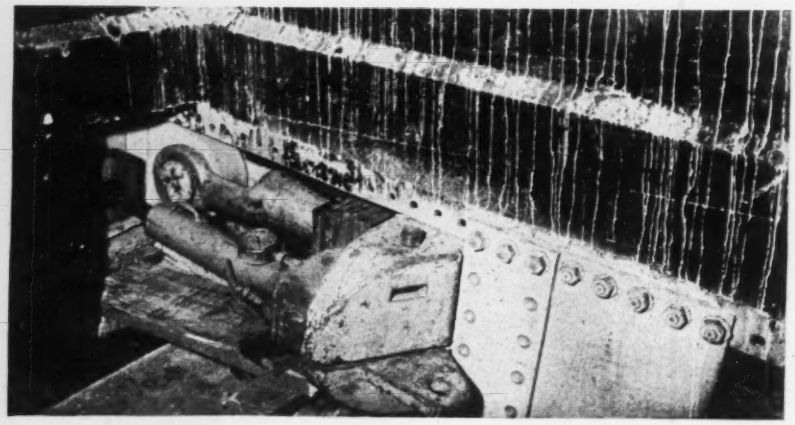


Fig. 4. Within the pontoon the cable passes through the rear jacking casting to the socketed end at left. Rear bearing plates in right foreground; at extreme right, cable on its way to the anchor.

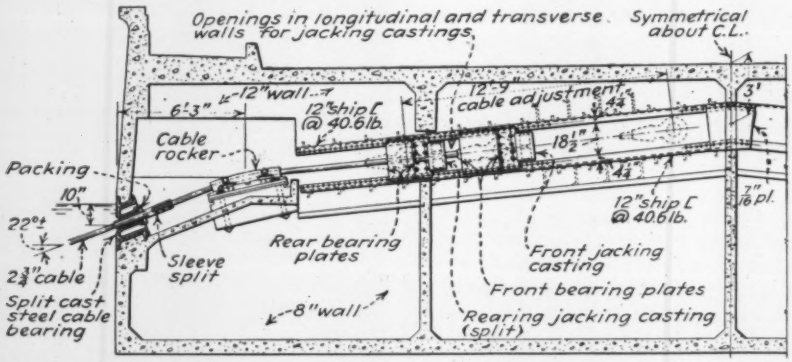


Fig. 5. Transverse half-section of pontoon showing arrangement for jacking and fastening cables.

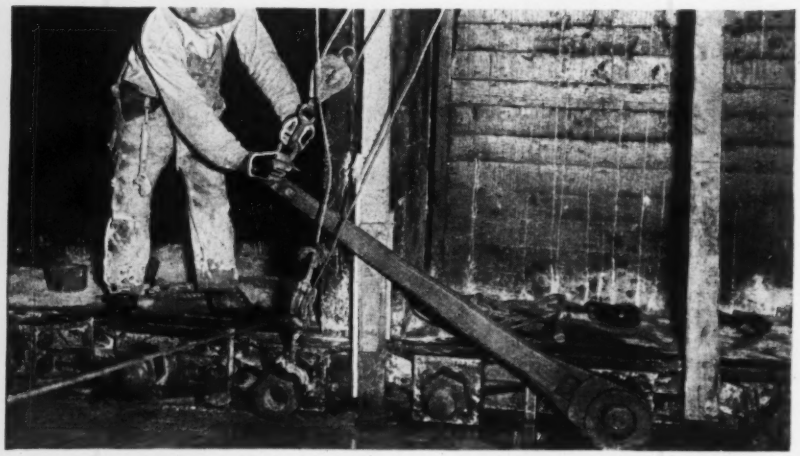


Fig. 6 Bolts in joints between pontoons are tightened with 4-part tackle giving a measured pull on a 5½-ft. ratchet wrench.

through the port, over a saddle and far enough into the anchor frame so that the rear jacking casting, which is made in two parts, can be put around the cable and clamped. The hauling line is then taken off, the front jacking casting is connected by means of a 6-in. pin through the eye of the socket and the anchor cable is in position for jacking operations.

The arrangement within the pontoon for jacking and fastening the cable (Fig. 5) is such that during jacking and after permanent fastening of the anchor cable, all parts, except the cable itself, are in compression or bending. Transferal of stress from the cable to the pontoon is by means of two sets of vertical bearing plates which extend from a 12-in. ship channel above to a similar shape below the cable slot in the middle transverse partition of the pontoon.

In the jacking operation, which is accomplished by two 25-ton hydraulic jacks (of a type provided with a dial which indicates pressure in pounds per square inch) the front and rear jacking casting are forced apart while the pull thereby put into the cable is transferred to the pontoon through the rear bearing plates. When the desired tension has been reached and the position of the pontoon has been checked for line, front bearing plates are bolted to the ship channels above and below as close to the front jacking castings as the bolt spacings will allow. Shims are placed between these plates and the forward casting, to take up any space there may be. As jacking is done simultaneously on both sides of the pontoon, by coordinating the jacking progress, the pontoon is kept in line by the balanced tension on the two sides. After jacking is completed, pumping out the water ballast adds a small buoyant force which tends to still further increase stability. After the jacks have been removed, the rear jacking castings are taken out and the split sleeves and bearing inserts are placed around the anchor cables just inside the cable port through the outer wall.

With the anchor cables stressed the prescribed amount, final tension is put on the bolts that fasten together the ends of adjoining pontoons. Uniform tension in these bolts is obtained by tightening up the nuts with a 5½-ft. ratchet wrench, doing the final tightening by a measured pull. This pull is applied by a 4-part tackle running from a small air hoist to the end of the wrench.

When these heavy bolts, of which there is a total of 52 in each joint, are bolted up they compress a rubber gasket that seals off a 1-in. space between the pontoon ends immediately surrounding the bolts. This space is pumped out and filled with grout.

All anchor cables are set for an angle of about 22 deg. with the horizontal; thus lengths vary directly with water depth. Cables in the shal-

low water will require adjustment as the water level fluctuates. The bridge design contemplates a maximum seasonal rise or fall of 18 in. either way (3-ft. total fluctuation) from "normal water surface" which is to be maintained at El. 8.00 by the ship locks between the lake and Puget Sound. Initial tension in anchor cables is allowed to range from 65,000 to 80,000 lb. and will be finally modified (probably downward) after the entire anchorage system is completed.

As an aid in adjusting cable tension to varying water level, two curves were plotted. One curve marks the straight-line effect of surface fluctuations on distance from pontoon to anchor and the other indicates the effect on this distance resultant from varying tension in the cables. The curves intersect at El. 8.00 and 65,000 lb.

ZINC COATING REQUIREMENT FOR INDIVIDUAL WIRES IN PONTOON ANCHOR CABLES.

Wire Diameter (inches)	Coating Weight (ounces per sq. ft.)
0.165 to 0.100	1.6
0.100 to 0.090	1.4
0.090 to 0.080	1.35
0.080 to 0.070	1.00
0.070 to 0.060	0.80

The anchor lines are galvanized "improved plow steel" bridge cables 2¾ in. in diameter consisting of seven strands, one of which is an independent wire rope center. The ultimate strength specified is 620,000 lb. A notable feature is the heavy coating of pure zinc on all wires, applied by electrical methods, to meet the minimum requirements given in the above table as to weight of coating in ounces per square foot of wire surface.

When the job reached the stage where it was time to begin putting tension in the anchor cables, the equipment first used consisted of a job-assembly of hydraulic jacks and pressure gages. Inaccuracy and inconvenience in manipulation soon led to the replacement of this equipment with the special hydraulic jacks.

The Lake Washington Bridge was constructed under the supervision of the Washington Toll Bridge Authority, L. V. Murrow, chief engineer; C. E. Andrew, principal consulting engineer. The contract for the floating structure was held by Pontoon Bridge Builders; C. F. Urbutt, general superintendent. Data for this article was supplied by Wm. A. Pomeroy of Pontoon Bridge Builders.

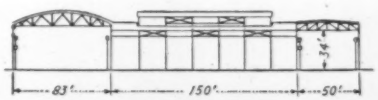
Timber Trusses Support Roofs Over 2½ Acres of Shops

TIMBER CONSTRUCTION is used exclusively in the shipyard recently completed at Tacoma, Wash., for the Seattle-Tacoma Shipbuilding Corp. which has a contract to build five 6,800-ton freighters for the U. S. Maritime Commission. The covered area includes 103,200 sq.ft. in a group of shop buildings adjoining two shipways that lead from the plant into Puget Sound.

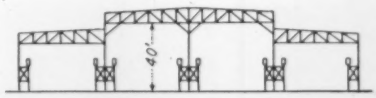
In the shops are 72 timber trusses with spans of 50 ft. or more; twelve have spans of 130 ft. Fabrication of trusses began Nov. 1, was completed Dec. 21 and their erection was finished the first week in January. The buildings include a two-story, 130x260-ft. mold loft; an 84x350-ft. assembly shop; two plate shops each 50x150 ft.; a slab shop and a blacksmith shop, each 50x150 ft., and a 50x200-ft. layout shop.

For the most part, truss spacings are 20 to 25 ft.; roofs are designed for a live load of 20 lb. per sq.ft. The roofing proper consists of 2-in. t. & g. planks on 6x12 or 6x14-in. purlins spaced 8 ft. on centers. Joints in Howe trusses are made with split ring connectors, and in the bowstring trusses all heel plates and metal fastenings are attached with flush type shear plates. For all top and bottom chords, select structural Douglas fir was specified and for smaller diagonal web members the grade was select merchantable.

The general contract was held by the General Construction Co., Seattle. Designs for the trusses were furnished by Timber Structures, Inc.



Main Elevation



Section Through Shops

Typical timber construction showing use of Howe trusses in 50x200-ft. layout shop.

Sabotage and Water Service

An Engineering News-Record Report

MOBILIZATION OF INDUSTRY for defense puts a new responsibility on municipal water officials. Probably no resource is more vital in times such as these—nor more vulnerable—than water service. What measures should be taken, therefore, to safeguard this essential service from sabotage?

To get a comprehensive answer to this question the editors of *Engineering News-Record* sought information from waterworks authorities in key industrial cities from coast to coast, interviewed state and national agencies concerned with defense activities and obtained the views of equipment manufacturers and consulting engineers. The following report summarizes the results of this canvass. It is designed to provide information that may be useful in establishing precautionary measures at every major water utility. And it is offered in the spirit that preparedness now will provide insurance against what could happen tomorrow.

This report is not intended to dramatize the situation nor do its contents give any excuse for hysteria. It was soberly conceived and calmly reviewed. It is hoped that its publication will prove a service to the waterworks profession whose responsibilities are always great but are increased many fold in these troubled times.

Sabotage of water supply as a means of paralyzing industrial production is no myth. The public press has already carried accounts of such activities. Other information brought to our attention reveals that disruption of municipal water service has been given more than a passing thought by saboteurs.

The argument will probably be raised that calling attention to the vulnerability of water service puts ideas into the heads of those planning sabotage. However, based on experiences reported from abroad and learned in the last war, it must be clear that those who plan sabotage are equipped with every possible bit of technical knowledge that is useful for their purposes. Under such circumstances the broadest dissemination of facts on counter measures and protective plans is necessary to provide assurance against damage. Such facts need not and should not include the names of the cities or localities where the specific precautionary measures are in force or being planned. And this report has been drafted so as not to reveal such locations, while at the same time providing a general program of safeguards from which may be chosen those which are most applicable to the condition at any individual water system.

First things first

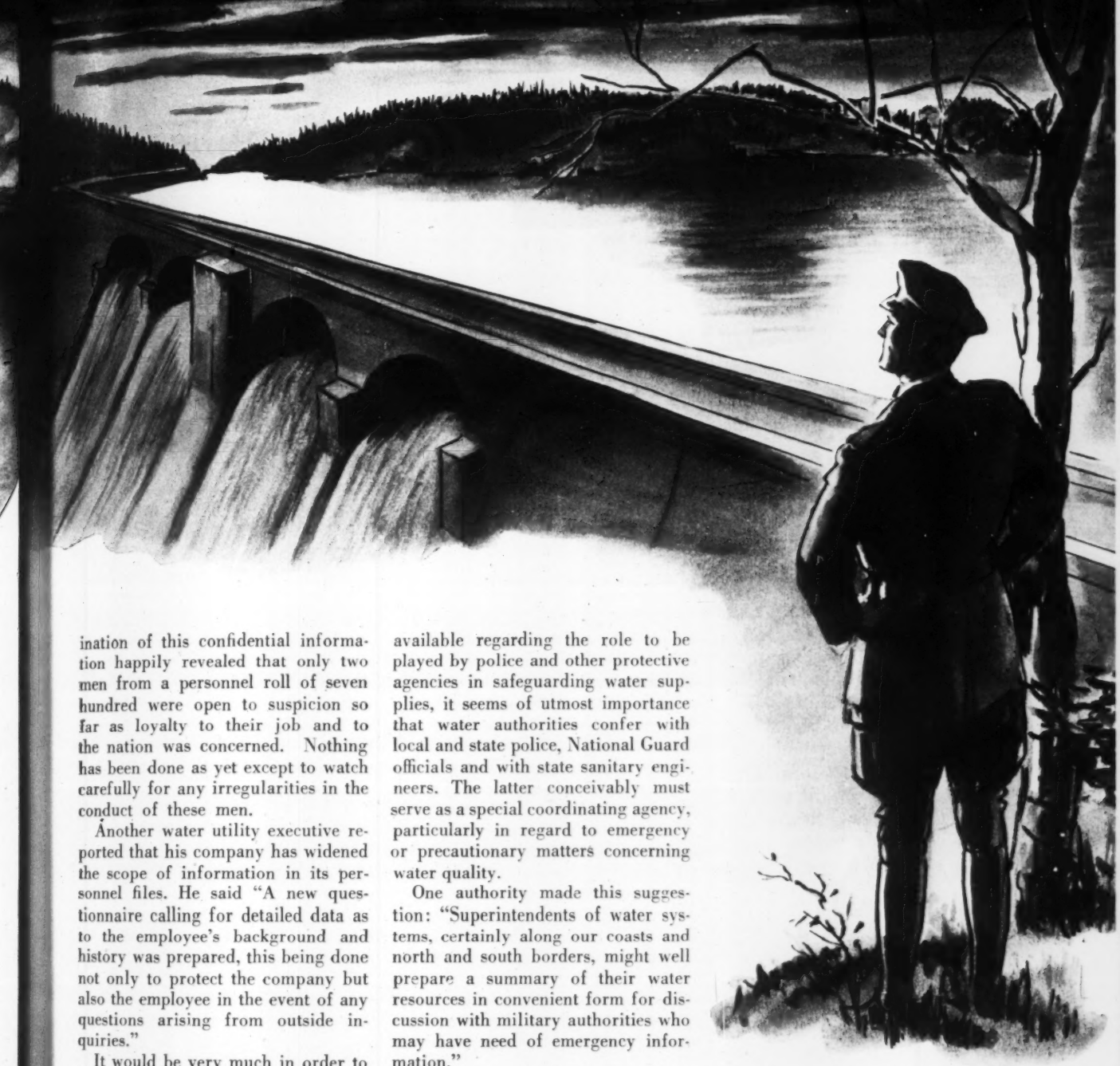
The initial step to be taken by a municipality preparing to safeguard its water system is to assign responsibility for this function to a competent, trustworthy individual or to a small committee selected from men already engaged in the water department. This is neither the time nor the occasion to introduce "politics" or fanfare; and the less publicity given the matter the better it will be for all concerned. In some of the cities surveyed this work logically has been or will be undertaken by the water superintendent or general manager working in close harmony with his division heads.

Plan of procedure

The next step is to adopt a plan of procedure—and then put this program into execution as rapidly and calmly as possible. Mix caution with precaution. This is particularly true when it becomes necessary to issue statements or instructions to personnel. Impress them with the gravity of the situation, but carefully eliminate all elements of alarm or hysteria which may unbalance morale.

In drafting a plan of procedure, the precautionary measures might be considered as falling into four categories: (1) those which are of general significance; (2) safeguards to sources of supply, such as dams, intakes and aqueducts; (3) safeguards to treatment works; and (4) elimination of distribution system weaknesses.

Regarding general precautions: One of the first steps taken by the waterworks department of a large industrial city was to make a thorough check on the affiliations and attitudes of all its employees. Exam-



ination of this confidential information happily revealed that only two men from a personnel roll of seven hundred were open to suspicion so far as loyalty to their job and to the nation was concerned. Nothing has been done as yet except to watch carefully for any irregularities in the conduct of these men.

Another water utility executive reported that his company has widened the scope of information in its personnel files. He said "A new questionnaire calling for detailed data as to the employee's background and history was prepared, this being done not only to protect the company but also the employee in the event of any questions arising from outside inquiries."

It would be very much in order to instruct all employees to report promptly upon incidents that depart from normal routine. In some places implicit instructions have already been issued and the following extract from a water board manager's letter is typical. He says, "We have instructed all our men to be on the lookout for any strangers; and to be sure to contact them, introduce themselves and draw them into conversation in order to determine their reasons for visiting the plant, what they are interested in, their home address, and any other general information so that we could identify them later should anything develop that would show their ill intent."

While little definite information is available regarding the role to be played by police and other protective agencies in safeguarding water supplies, it seems of utmost importance that water authorities confer with local and state police, National Guard officials and with state sanitary engineers. The latter conceivably must serve as a special coordinating agency, particularly in regard to emergency or precautionary matters concerning water quality.

One authority made this suggestion: "Superintendents of water systems, certainly along our coasts and north and south borders, might well prepare a summary of their water resources in convenient form for discussion with military authorities who may have need of emergency information."

An important suggestion is the proposal of one city to build up its inventory of repair and emergency material, and to keep certain material at strategically located points for quick accessibility. Particular emphasis has been placed on securing extra supplies of timber and other construction materials, as well as valves, pipe in various sizes and lengths, couplings and other spare parts.

Naturally, a large financial outlay is involved but this is considered secondary in view of possible delays in getting supplies later and of the higher prices which may have to be paid when the defense program is in full swing.

The possibility of power outages and interruptions of the operation of major equipment such as pumps, calls attention to the installation of standby units and to the promotion of plans for emergency service needs. This is an individual matter for each system, and consequently calls for separate consideration, but it must not be overlooked in a plan of preparedness.

Sources of supply

Providing protection to the physical structures of the sources of supply such as dams, intakes and aqueducts, is an exceedingly difficult matter. Generally, these structures are located in isolated areas, or in

Sabotage Safeguards for Water Supplies

GENERAL

Assign responsibility for carrying out the program to a competent individual or small committee.

Formulate a plan of procedure—and execute this plan as quickly as possible.

Check the affiliations and attitudes of all water department employees.

Instruct all employees to report all incidents that depart from normal routine.

Confer with local police, state police, National Guard and other protective agencies concerning special problems.

Create an adequate reserve of supplies, repair and emergency materials.

Provide standby power facilities and otherwise insure functioning of vital equipment in case of emergency.

SOURCES OF SUPPLY

Bar visitors and fishing in the vicinity of dams and intakes.

Provide extra lights at intakes, and consider plans for the use or installation of supplemental intake facilities.

Supplement existing telephone or wire communication systems to isolated points with radio and personal messenger service.

Establish a patrol system along aqueducts and other structures, paying particular attention to vital points such as meter and valve control stations.

Prohibit parking at all times on stretches of road which pass near dams or aqueduct lines.

Restrict airplane operations in the vicinity of reservoirs and dams.

Minimize identification of access manholes and shaft entrances to tunnels and aqueducts.

TREATMENT PLANT

Bar all visitors from waterworks properties.

Consider the use of fence enclosures.

Make frequent inspection of operating equipment, automatic devices, valve mechanisms and standby equipment.

Increase the frequency of water sampling and analysis to insure prompt determination of contamination.

Frequently examine chlorinating equipment and supplies of chlorine.

Maintain an adequate reserve of treatment chemicals.

DISTRIBUTION SYSTEM

Complete all improvements essential to good service requirements.

Install additional valves so that sections of the system may be isolated without major shutdowns.

Interconnect the grid system so that all areas can be served from two or more points.

Provide industrial areas with adequate capacity mains for processing uses and fire demands.

Augment service and maintenance crews, and provide special training for emergency needs.

the case of pipelines, pass through country that is sparsely populated. Yet these are extremely vital parts of a water system and precautions cannot be ignored.

One water superintendent stated, "All of our points of intake and control are at the present time well lighted, and have one or more employees on duty 24 hours a day. Our transmission mains are patrolled several times daily, and yet we recognize that in common with all water systems of consequence, we are not guarded in anything like an adequate manner should there be a wave of sabotage. But I recognize that to fully guard many miles of right-of-way on which there are several transmission mains will require more men than we can possibly afford, and these men must have more power than we can delegate to our employees. It is my opinion that nothing short of military patrols could afford actual full protection."

At another place where a number of dams and transmission mains are spread over a wide area, consideration is being given to the use of short wave radio and a personal messenger system to supplement existing telephone and wire facilities. Thus, patrol units and maintenance crews will be assured of intercommunication in case of emergency.

The principal precautionary measures at dams and intakes have been to curtail fishing in the vicinity of these structures. It would also be practical to restrict the operation of airplanes in the vicinity of dams and reservoirs. In the case of intakes, special floodlighting facilities have been suggested, one city in the Great Lakes area, for instance, is reported to be spending $20,000 on such lighting provisions.

Because intakes are particularly vital and also difficult to repair quickly, consideration might well be given to the use of substitute facilities for obtaining a raw water supply if normal service is disrupted. In fact, the materials and rigging for supplemental intakes could be kept at hand. At the very least, a plan should be evolved outlining what is to be done in an emergency.

Increased patrol activity with special attention to important valves and meter control stations should be instituted. In this connection all public highways and streets in the vicinity of dams and other structures could be posted with "no parking" signs, and this regulation rigidly enforced. State highways and local police officials will no doubt cooperate in making such measures effective. And to further this action a special force of deputies, clothed with proper police powers, might be organized using men already employed in the water department.

Aqueducts and supply mains are more vulnerable, perhaps, than any other structure in the water system. Even with constant patrolling, many opportunities are afforded for doing at least temporary damage. Recognizing the ease by which dynamite could be dropped into a tunnel through access manholes, one water commission has lowered these manholes below the ground. After making careful location measurements of the dropped manholes, the holes were backfilled and the ground surface sodded.

Elevated storage tanks should be fenced and carefully watched.

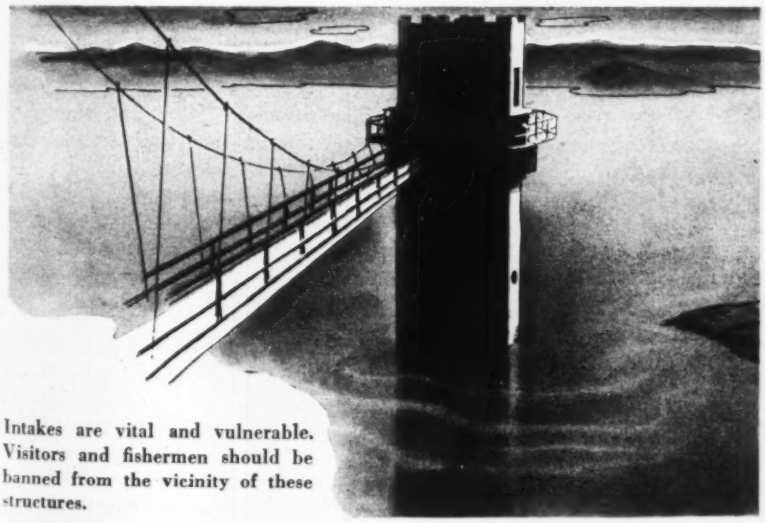
Treatment plant precautions

Treatment works and pumping plants may be more easily safeguarded than other structures, provided certain precautions are taken. There is common agreement, for instance, on banning visitors from all waterworks properties at the present time, and in some places this regulation has been in effect for several months.

A few cities have inclosed their properties with fences, the gates of which are locked after dark. One superintendent reported as follows: "At the time of the World War the question of sabotage came up, and we constructed a heavy 10-ft. wire fence around the purification plant grounds and had a force patrolling this fence. The fence is still in place although extra gates have been cut through for easy access. At the present time these gates are open but it is our intention in case of necessity to have them closed, exclude visitors and put guards around the fence."

Special attention should be focused on plant equipment operation and performance. This calls for frequent inspection of all moving parts and automatic devices, testing of valve mechanisms, and trial runs with standby equipment.

Impairment of water quality is possible but not probable. Sabotage



Intakes are vital and vulnerable. Visitors and fishermen should be banned from the vicinity of these structures.

now would be directed toward paralyzing industrial activities, and little could be accomplished in this direction by attempts to poison water or to innoculate it with pathogenic bacteria. Records from the last World War show few attempts, if any, to poison water even in the combatant areas. That the situation may be different today is implied, however, in a recent dispatch from Paris which stated that a harmless blue or green dye was to be pumped into the water supply when and if any real contamination was discovered.

It would seem desirable, therefore, to increase the number of sampling periods and make more frequent analyses of water. Experts report that it would take tremendous quantities of toxic substances to contaminate a supply, but they point out that certain compounds added to water would invalidate results from analyses, and thus give a false sense of security.

Precautions to safeguard quality standards should also include careful inspection of chlorinating equipment to assure proper functioning at all times. Reserve stocks of chlorine gas might be kept on hand, along with emergency gas or solution-feed type equipment, preferably that which is mobile. Chlorine gas itself might be used with criminal intent, and it is further recommended that cylinders of such gas be kept in a locked enclosure or otherwise rendered immobile.

Distribution system precautions

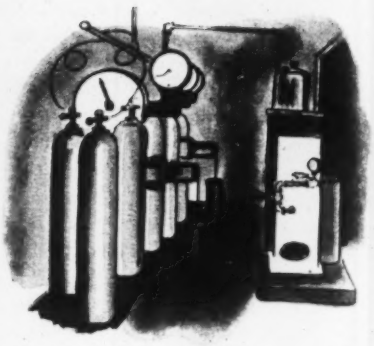
In many respects the precautionary measures to be undertaken with regard to the distribution system are simply an extension of normal improvement measures. The distributing network of pipe must be adequately valved so that sections may be isolated, a sufficient number of interconnecting mains should be provided so that all areas can be served from two or more points, and pipe should be cleaned and of sufficient capacity to meet peak demand. If these essentials of good practice are already incorporated in the system, then the essential precautionary measures have been taken.

Unfortunately, many of our distribution systems are in need of attention because improvements were deferred during the recent financial depression. Immediate action must be taken to correct these deficiencies, and waterworks managers never had stronger reason to plead for funds and authority to go ahead with such betterments. It is obvious, of course, that precedence should be given to work in industrial areas.

In this connection, it is interesting to quote from the letter of a chief engineer in one of our smaller cities. He says, "Nothing has been done at the present time to safeguard the public water supply from possible sabotage. However, an expenditure of approximately $250,000 was made last year, duplicating the essential parts of the former supply; one of the main reasons for which was the possibility (sabotage) which you mention."

Aside from improvements to the physical structures, attention must be given to organization planning for emergency service. Maintenance and service divisions of the water department need to be augmented and given special instructions covering real or fancied catastrophes. Training courses to develop facility in doing particular kinds of work, and frequent drills in locating and operating valves to meet certain conditions might form an integral part of the instruction procedure. A well organized emergency crew is a primary defense against the activities of saboteurs.

Challenging the ingenuity of waterworks officials who must provide safeguards are aqueducts in exposed and remote locations.



First line of defense in maintaining water quality are the chlorinating facilities.

Federal and state aid

The role to be played by the Federal Bureau of Investigation and the National Guard with specific reference to the protection of water supplies has not yet been publicly defined.

However, in testimony given before a Congressional committee, it was stated by J. Edgar Hoover, director of F.B.I., that in September, 1939, his bureau was assigned to bring coordination between the intelligence divisions of the Army and the Navy. Under present arrangements the FBI handles all civilian investigations dealing with the various phases of national defense work, and the military and navy intelligence divisions are confining their activities to the armed forces.

The FBI has established a unit called the General Intelligence Division which has supervision of espionage, sabotage and other subversive matters. One phase of this work concerns plant-protection where war materials are manufactured. "We do not furnish protection to a plant," said Mr. Hoover, "but our position is that of advisor on technical matters in connection with plant protection."

Since both the President and the Attorney General of the United States have publicly invited all persons to call upon local FBI offices (there are 52 such offices now operating) should they wish aid or desire to transmit information in regard to sabotage, it would seem logical for waterworks authorities to assume that this service is available to them.

Concerning aid from the National Guard, several cities reported that they had conferred with this agency on matters of protection to water supplies in case of an emergency.

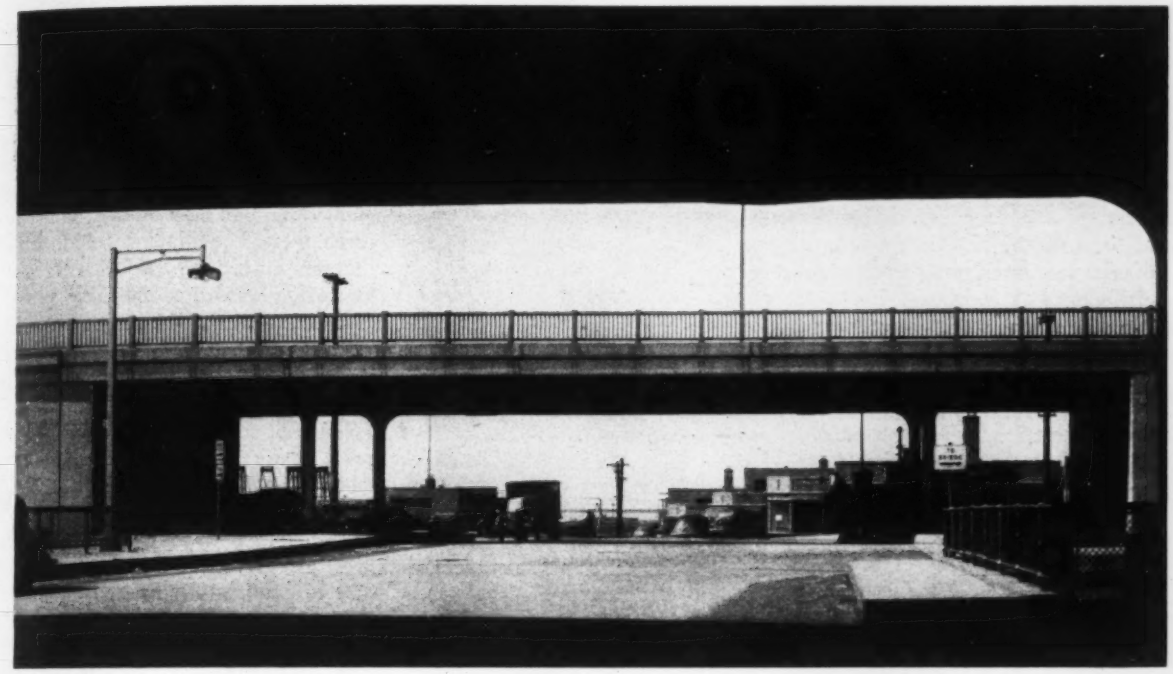


FIG. 1. ONE OF CLEVELAND'S WELDED BRIDGES AS IT LOOKS FROM BENEATH THE DUPLICATE BRIDGE ALONGSIDE.

Welded Rigid Frames, European Style

FRED L. PLUMMER
Chief Design Engineer, Main Ave. Bridge Project
Cleveland, Ohio

***Contents in Brief**—Some of the first all-welded rigid frame bridges in this country form part of the approaches to Cleveland's new Main Ave. Bridge. The principal detail of note is the transition section between the girders and the supporting columns that occur between the short side spans and the 70-ft. center span. Built up of flanges and three web plates, with an efficient and presentable stiffener layout, the detail is designed particularly to eliminate biaxial or triaxial stresses that might cause "brittle" failure.*

ALTHOUGH WELDING has been used extensively in the United States for strengthening old bridges and for the fabrication of such auxiliary parts as shoes, expansion dams, floors, curbs and rails, very few all-welded bridges have been built. Those that have utilized welding exclusively have, in the main, been simple plate girder or truss structures in contrast to the several hundred rigid frames, Vierendeel trusses and other types that have been built in Europe, particularly in Germany and Belgium. Probably the nearest American approach to European practice in rigid frame construction occurs in two similar structures that form part of the west approach of the Main Ave. Bridge project in Cleveland. To those not familiar with European developments, a description of these bridges should prove instructive.

Each bridge is a slightly skewed three-span structure carrying the 34-ft. roadways of the north and south ramps over West 28th St. on two continuous frames spaced about 26½ ft. apart. Narrow escape walks bring the total width of each bridge to 40½ ft. The roadway on each bridge is built to a vertical curve, and on one of the structures a horizontal curve is also used. The center spans are about 70 ft. flanked with short side spans of 25 to 30 ft. Except for riveted fascias, used to conform with adjacent riveted structures, the two bridges are completely welded.

Welded frames

The continuous welded frames are fabricated from standard wide-flange sections except for the transition sections *A* located at the tops of the interior columns as shown in Fig. 2. Since service requirements to a large extent fixed the ratio of center span to side spans, it was found to be more economical not to provide a rigid connection at *B* between the girders and the end columns. At these points the girders rest on and are bolted to bearing plates welded to the tops of the columns.

The transition sections *A* provide for full continuity between the girders and the interior columns. These sections were formed by flame cutting out a section of the flange and ad-

jacent web of the girder to a depth of 3 in. from the outside of the flange. The transition section was then built up and shop-welded to the girder as shown in detail in Fig. 2. The web consists of three plates while the flange is a single plate of the same thickness as that of the flange of the girder and the column. The center vertical stiffener was provided to receive and distribute the floorbeam reaction while the purpose of the other stiffeners is to support the curved compression flange and to stiffen the highly stressed web adjacent to this flange. In determining the spacing and location of these stiffeners consideration was also given to the appearance of the resulting structure.

Web plates

The outside web plates were used for two reasons. First, both tests and analytical studies indicate that in such sharply curved sections very high compression and shear stresses are created in the inner flange and adjacent web, whereas relatively low tension and shear stresses are built up in the outer flange and adjacent web. Second, experience in Europe has indicated that the intersection and overlapping of welds in corners or at other points where the surrounding metal is held rigidly may result in the creation of biaxial or triaxial stresses, which will cause the weld metal to fail as a very brittle material rather than as a ductile metal. The use of these outside plates provided a very small but it is believed sufficient amount of lateral flexibility to eliminate the possibility of such a "brittle material" failure. European engineers, who frequently use "cutouts" in all stiffeners and lateral plates to avoid such weld intersections, have commented very favorably on this feature of the design.

Fig. 3. Joining the shop-welded girder transition section to its supporting column.

The only field welds in the frames were made at *C* and *D*, Fig. 2. The four columns were erected first and bolted to the base plates and concrete piers. The columns were finished at the lower end for bearing and were not welded to the base plates. An end section of the girder was then swung in position, bolted to the end column at *B* and tack-welded to the inner column at *C*. The other end section of the girder was then placed and finally the center section of girder was dropped into position resting on the lower flange splice plates which had been shop-welded to the end girder sections. The erection of the two frames was carried on simultaneously, and floorbeams were placed in position to provide lateral stability. This procedure made possible quick erection without the use of any falsework.

The floor system

The floor system provides the only lateral bracing except for cross frames in the planes of the end columns. These columns and the cross-bracing are concealed by concrete curtain walls. Thus all lateral forces due to wind and centrifugal action are efficiently carried by the floor

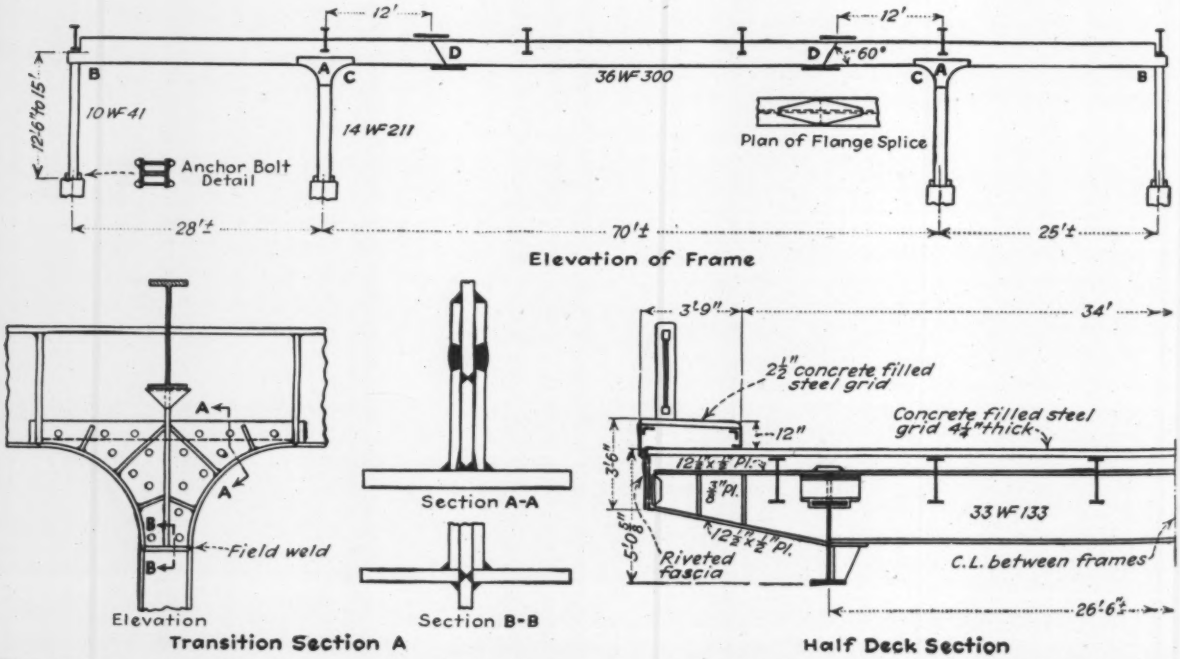


Fig. 2. Structural details of the two welded rigid frame bridges that form part of the Main Ave. Bridge approach in Cleveland.

system, acting as a horizontal girder, to the end columns, and then by the sway bracing down to the tops of the concrete piers.

A simplified typical cross-section is shown in Fig. 2. The floorbeams and stringers are rolled wide-flange beams whereas the floorbeam brackets are tapered welded girder sections. The curb is a welded assembly. Stringers and diaphragms are rolled beam sections and are in general supported on seat angles.

The floor on each of these bridges has no crown, all drainage being carried to the finger expansion joints which are located at each end. Water drops through these joints and is guided by a complete system of copper flashing into cross-troughs, and then through hoppers and downspouts into the drainage sewers. All of these drainage facilities are located behind the curtain walls and are therefore not exposed to view.

Railing and lights

The railing on these and other structures included in this project (a total length of railing of about 3 miles) is a welded assembly consisting of 8-in. square posts (with larger posts on the main superstructure) and removable panels varying from 6 to 8 ft. in length. The panels consist of a top rail 4x5 in., a bottom rail 4 in. square, and spindles 2½ in. square, all made of standard tubing, ⅛ in. thick for the spindles and ¼ in. for the rails.

Light standards were designed especially for this project and consist of square tapered tubular shafts with brackets of square tubing supporting sodium vapor light units 25 ft. above the roadway. On these two bridges the light standards are carried on the railing posts whereas elsewhere in the project they are supported on the sidewalk adjacent to the curb.

Design considerations

An H-20 loading was assumed in the design. The stringers were designed and detailed for full continuity for the entire length of the structures. Similarly, each floorbeam and its corresponding cantilever brackets were designed for fully continuous joints. For the welded frames hinged supports were assumed at the tops of the end columns, 80 per cent fixed supports at the bottom of the interior columns, and fully continuous joints at the tops of the interior columns.

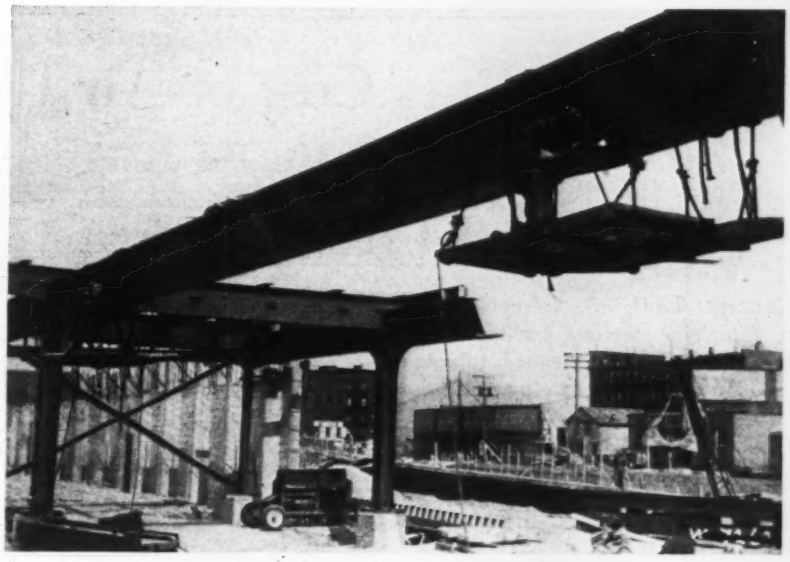


Fig. 4. Erection of the frames was a simple process. Here welders are making the girder splices after the middle section of the center span has been lifted into place on the lower flange splice plates, which have been previously shop-welded to the end sections of this girder.

The end columns were designed to carry the superimposed load, giving due consideration to bending from longitudinal, lateral and temperature forces, and to the bending imposed upon the top of the column by the deflection of the adjacent girders of the frame.

Saving by welding

The welded structure as built represents a saving in material of the order of 10 to 15 per cent as compared to a riveted structure designed to give the same strength factors. Since the steel for these two bridges was included with several thousand tons of riveted steel on a single unit price basis it is not possible to determine whether the actual unit cost for welded fabrication and erection was materially different from that for comparable riveted bridges. It would seem probable, however, that the welded design may have resulted in some economy.

The bridges as built are believed to represent a safe, economical, and in general a very conservative application of welding in one of the few fields in which it has to date made relatively little progress in this country. It is hoped that the successful use of welding for these structures may stimulate its further conservative use for other similar proper applications. The failure of the Hasselt Bridge in Belgium two years ago (*ENR*, May 5, 1938, p. 564, and Aug. 18, 1938, p. 204) is ample proof that such designs must be based on careful study by competent engineers.

Direction

The entire Main Ave. Bridge project, including the bridges described in this article, was designed and constructed under the supervision of the office of Cuyahoga County Engineer John O. McWilliams with W. E. Blaser as bridge engineer and Ralph W. Deitrick as resident engineer. The writer was chief design engineer. The steel was fabricated by the Mount Vernon Bridge Co. and erected by the Bass Construction Co., acting as subcontractors of Sam W. Emerson Co.

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Unusual Bridge Repair Job

At a 90-ft. shallow through-truss double-track railway bridge crossing another railway near Glasgow, Scotland, one abutment started to tilt forward, but with the tracks below there was no room to place a temporary support for the bridge to allow reconstruction of the abutment. The expedient adopted to meet this difficulty was to bolt onto the end of one truss a 12-ft. plate-girder extension and seat this on a support behind the abutment. After this part of the abutment had been reconstructed, the extension member was removed and then bolted to the other truss for completion of the work.

Welding Cuts Cost of Air Lines Terminal

LaMotte Grover

Structural Welding Engineer, Air Reduction Sales Company, New York, N. Y.

Contents in Brief—All-welded construction of heavy structural frame of joint city terminal for air lines in New York saves 100 tons of steel and simplifies complicated connections. Direct welding of web members of heavy trusses eliminates most gusset plates. Slot welding used at many points.

ALL-WELDED CONSTRUCTION is used in the steel frame of the Air Lines Terminal in New York, now in process of completion, and thus the newest method of steel assembly is represented in the world's largest building devoted exclusively to the newest method of transportation. Structural welding was adopted because of its economy over riveting.

The Air Lines Terminal occupies the site of the old Belmont Hotel on 42nd St. and Park Ave., opposite Grand Central Station. The hotel, which was built simultaneous with the city's first rapid-transit subway and partly over the subway structure, was taken down some years ago, but some of its substructure framing was left in place and the new terminal had to connect to it as part of the foundation. This was one of the conditions that affected the design. Another arose from the fact that the main waiting room of the new terminal had to span a theater that was to occupy a large part of the ground floor. Also, provision had to be made for two mezzanines in the waiting room, for bus ramps and elevators, and for passenger escalators to connect the unloading platform in the basement with the waiting room one level above 42nd St.

Thus, though the building is not large (ground plan 105 x 200 ft., five stories above the street and four stories below), its frame includes two 70-ft. trusses weighing 30 tons each and a number of heavy plate girders, the largest of which spans 54 ft. With 1,365 tons of steel framing, it is the ranking welded structure in New York City as to both size and interest.

Photo: George M. Mathieu

Fig. 1. Simple and impressive exterior characterizes the Air Lines Terminal. View of 42nd Street front as seen from Grand Central Terminal.

Low bid for welding

The original design did not anticipate extensive use of welding, but the lowest bid was for welded construction and resulted in saving more than 100 tons of steel. Much of the saving was in the trusses and other heavy units, as the welded design permitted utilization of the full section of the members efficiently.

Additional advantages of welding appeared in the connection to the old steel, which in case of riveting would have involved much costly field drilling for connections, and in the special framing at the escalators, stairways and ramps. At some points it was necessary to distribute column reactions to avoid overloading existing subway girders, and here also welded details proved simple and economical.

Interesting welding details

Chief among the items of special design for welding are the framing details at the south end of the terminal floor, which is suspended over the theater by a truss and girder system overhead.

Heavy Trusses—Two 30-ton trusses spanning 70 ft. are the main elements of support over the theater, as may be seen from Fig. 5. They carry five floors or about 1,275 tons of load, and are believed to be the heaviest welded building trusses ever constructed. Through hangers from a 54-ft. plate girder spanning between them near their south ends they carry the waiting room floor.

By virtue of welding, most of the truss joints (Fig. 8) could be made without gussets. At the south end of each truss, fillet- and slot-welded gussets were used to develop sufficient connection area, but much larger gus-

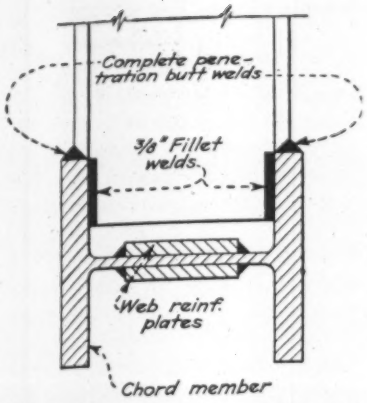


Fig. 2. Web-member connection to truss chords.

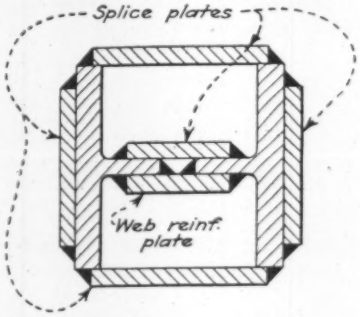


Fig. 3. Bottom chord splice in truss.

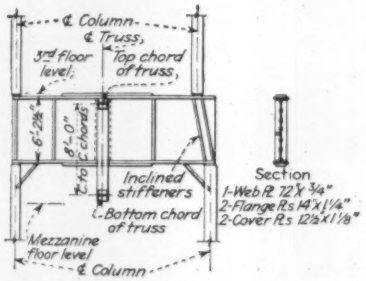


Fig. 4. Welded girder at south end of east truss.

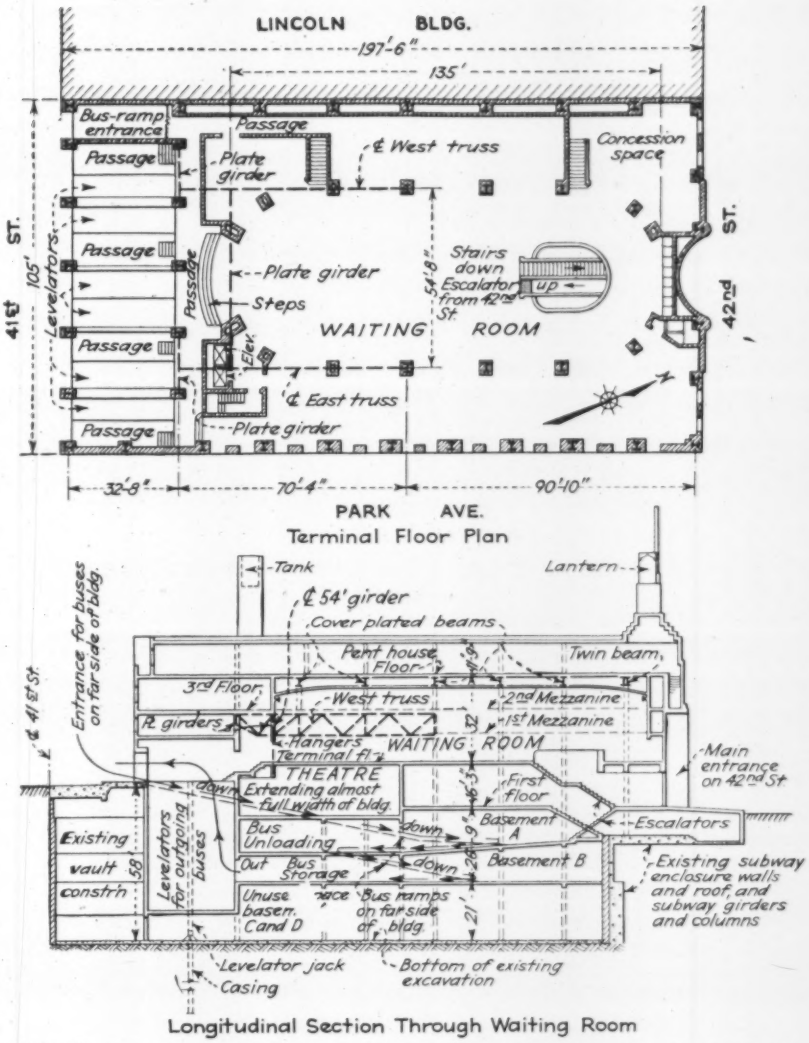


Fig. 5. Service requirements combined with the presence of old steelwork in the substructure led to complicated framing for the Air Lines Terminal.

sets would have been required for a riveted connection. At intermediate panel points the web members are generally connected to the chords by butt-welding the web-member flanges to the chord flanges (Fig. 2) and carrying the web of the post or diagonal down between the chord flanges for additional fillet welding.

Generally the truss members are 14-in. wide-flange sections, but some web tension members are pairs of heavy plates stayed at intervals by longitudinal plate diaphragms; these plate members lap over the chords and are connected to them by fillet and slot welding.

As each truss was fabricated and shipped in two sections, the chords and one web member had to be field-spliced. The tension chord splice (Fig. 3), which carries a maximum stress of 1,770,000 lb., is of the strapped type. At this point the bottom chord has two web reinforcing plates, but the upper of the two is broken on either side of the joint and is replaced by a splice-plate, while the bottom one is lapped past the joint to help develop the splice. Fillet welds in slots and across the ends of the splice plates supplement the fillets along the longitudinal edges. The stress transfer is distributed by making the splice plates of different length. Investigation for critical section had to be made at several points. The compression chord splice is simpler, being mainly developed through milled bearing; the flange reinforcing plates on either side of the H-section are butt-welded at the splice to provide lateral stability. Shrinkage of these welds assured tight bearing between the milled surfaces.

To simplify the field welding at the connection of the north end of each truss to its supporting column, a short section of the column was built into the truss, being shopwelded to the top chord and the end diagonal, and this section was then field-spliced into the supporting column.

Plate Girders—Because of the position of the building columns, the south ends of the trusses, one of them with a reaction of 800,000 lb., had to be carried by short plate girders (Fig. 4). These are composed simply of two flange plates fillet-welded to a web-plate, with bar stiffeners where required. They also provide for offsets in some of the columns, and welding permitted these offsets to be

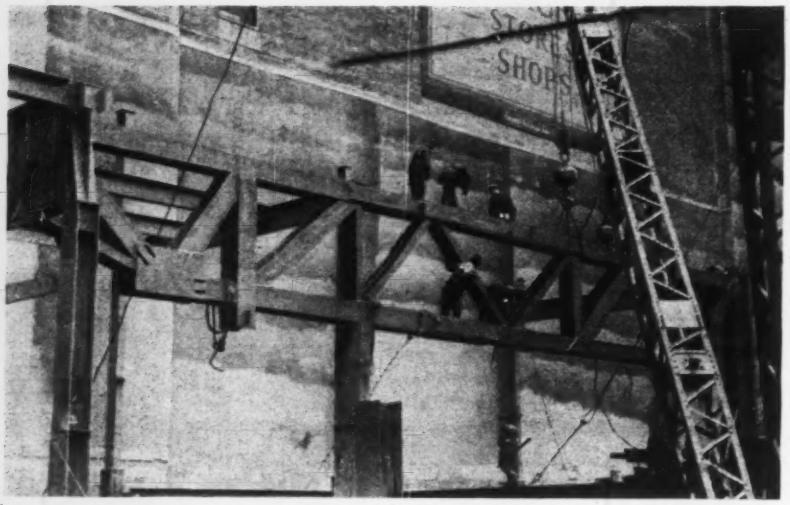


Fig. 6. Truss and girder framing supports five stories of the terminal building.

handled quite readily by attaching inclined bar stiffeners to the girder webs, virtually continuing the column section from the upper to the lower story length.

Diaphragms and Hangers—Ingenious use of welding is also apparent in the stiffening diaphragms of some twin plate girders and beams (Fig. 9). The diaphragms are attached to one of the beams by edge fillets, but the final welds, to the second beam, are made in slots from the outside, thus eliminating work in restricted space. Similar use of slot welding simplified the hanger framing by which an intersecting girder is supported from one of these twin girders (Fig. 9).

Coverplated Beams—Heavy coverplated beams weighing 10½ tons each, required in the 54-ft. span of the penthouse floor over the waiting room, also gave occasion for economy through welding. These beams, 36 in. by 230 lb., have 18 x 1⅝-in. coverplates attached by intermittent welds. Drilling rivet holes in the thick flanges and coverplates would have been costly, and increased metal area would have been required.

Beam Connections—Numerous interesting details were developed for beam connections. Where the code permits bolting, connection tees are welded to the minor beams and their outstanding legs are bolted to the web of the major beam. At other points connection angles have 2 to 6 erection bolt holes in their outstanding legs (except where a seat angle is provided) and the connection angles are fillet-welded to the supporting member.

Somewhat heavier connections of two types are shown at *A* and *B* in Fig. 10. Here a tee (half of an 8-in. 23-lb. beam) is shop-welded to the side of a column, and the web of the connecting beam laps past the outstanding leg of the tee; temporary bolt support is followed by welding along the outer edge of the tee and (to eliminate the necessity for fillet welding at the inner end of the beam web, a difficult location) in slots as shown. For the heavier connection of the two, a connection plate on the far side of the beam web is added, with fillet welds at both outer and inner edges. A special connection, that of a beam to an existing column, *C* in Fig. 10, also depends on use of slot-welding. Certain wind-bracing connections were detailed for partial flexibility (*D* in Fig. 10). The connection plate at the upper flange is welded only near its ends, leaving several inches of its length free to stretch, so as to limit the negative load moment.

Shop and field methods

Direct-current welding generators were used both in shop and field. The shop machines were motor-generator sets, while field welding was done with gas-engine sets. In both cases an all-position electrode with heavy flux covering was used, generally of $\frac{5}{32}$ and $\frac{3}{16}$-in. core diameter.

Fabrication of the steelwork was by the Lehigh Structural Steel Co., Allentown (Wm. H. Mohr, plant manager, and George Neuman, superintendent). The fabricators report that the work proceeded faster than riveted fabrication. There was not enough duplication of parts to justify the use of jigs or fixtures. The work was laid out directly on the members by measurement and chalk line, with the aid of templates for marking lines for gas cutting on truss members. Edges were beveled for welding grooves by gas cutting. Assemblies were for the most part fitted and aligned by steel tape, steel square, carpenter's level, clamps, blocks and steel angle sections, and then tackwelded prior to final shop welding. All work was positioned for downhand welding, and in some cases tilted for flat-position fillet welding.

Efficient shopwork may be credited in part to absence of interference between various types of work, as one large bay of the shop is devoted almost exclusively to welding. Overhead cranes in this bay handled and turned the welded pieces. The two heavy trusses, fabricated each in two sections, were match-marked in the shop to insure accuracy of erection. Care in the shop led to remarkably good fit-up in erection.

Steel was erected by the Lehigh Construction Co. (W. A. Gardner, manager of construction). Bethlehem Engineering Corp. was general contractor (C. O. Keith, superintendent).

The structural steel was designed by Jacob Langfur, for John B. Peterkin, architect for the building. The welding designs were executed by Gilbert D. Fish, who also was responsible for inspection of the welding.

Fig. 7. Truss assembly in a separate bay of the shop kept the welding free from interference.

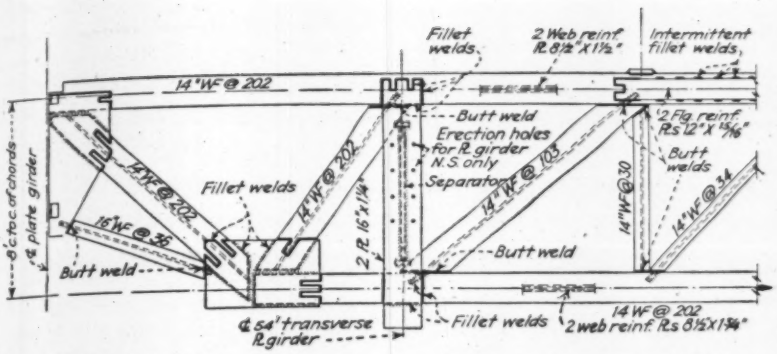


Fig. 8. Most joints of the heavy trusses were made by welding without gussets.

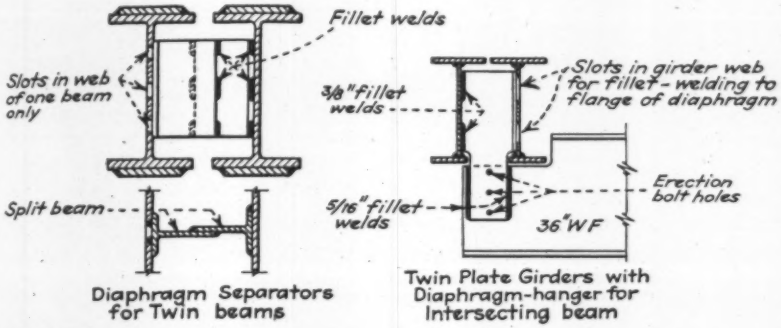

Fillet welds
Slots in web of one beam only
Split beam
Diaphragm Separators for Twin beams
⅜" Fillet welds
Slots in girder web for fillet-welding to flange of diaphragm
Erection bolt holes
5/16" Fillet welds
36"WF
Twin Plate Girders with Diaphragm-hanger for Intersecting beam

Fig. 9. Slot welds proved efficient for special details.

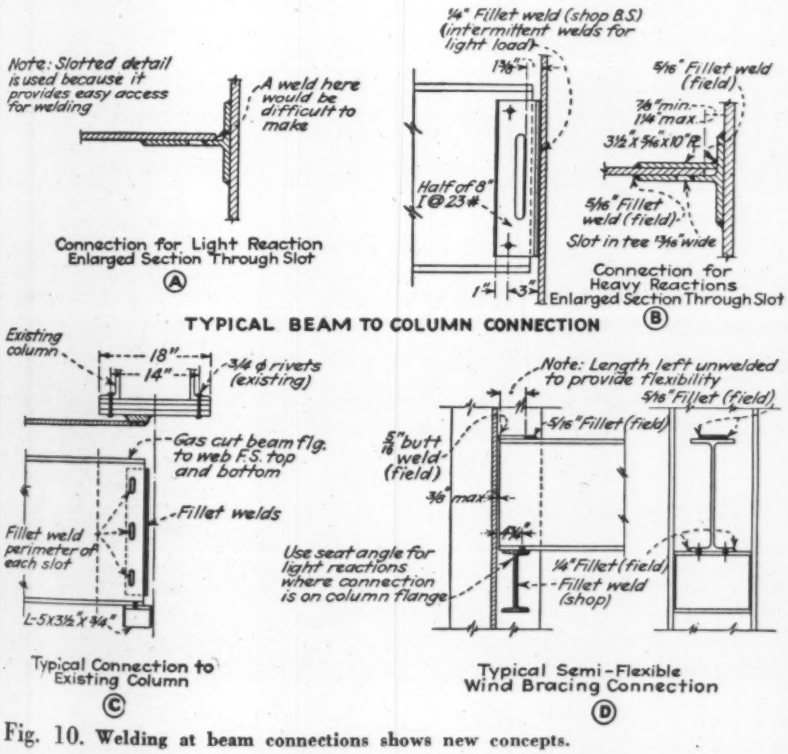

¼" Fillet weld (shop B.S.) (intermittent welds for light load)
Note: Slotted detail is used because it provides easy access for welding
A weld here would be difficult to make
Connection for Light Reaction Enlarged Section Through Slot
Ⓐ
1⅜"
5/16" Fillet weld (field)
⅞" min. 1¼" max
3½"x5/16"x10'-½"
Half of 8" I @ 23#
5/16" Fillet weld (field)
Slot in tee 13/16" wide
1¾"
3"
Connection for Heavy Reactions Enlarged Section Through Slot
Ⓑ
TYPICAL BEAM TO COLUMN CONNECTION
Existing column
18"
14"
¾ ¢ rivets (existing)
Gas cut beam flg. to web F.S. top and bottom
Fillet welds
Fillet weld perimeter of each slot
L-5x3½"x¾"
Typical Connection to Existing Column
Ⓒ
Note: Length left unwelded to provide flexibility
5/16" Fillet (field)
5/16" Fillet (field)
5/16" butt weld (field)
⅜" max
¼"
Use seat angle for light reactions where connection is on column flange
¼" Fillet (field)
Fillet weld (shop)
Typical Semi-Flexible Wind Bracing Connection
Ⓓ

Fig. 10. Welding at beam connections shows new concepts.

GENERAL DATA ON THE AIR LINES TERMINAL

The building is the terminus of transfer buses from the North Beach Airport (La Guardia Field), which bring passengers from five major air-transport systems—TWA, United Air Lines, American Air Lines, Eastern Air Lines, and the Pan-American Airways. Buses enter the terminal at the 41st St. side, descend by a ramp along the west side of the building to the platform for arriving passengers in the first basement, and then down to the second basement for baggage unloading and temporary storage of the buses. Buses leaving for the airport are lifted from the storage level by lifts or "levelators" at the 41st St. end of the building to street level, where they are boarded by departing passengers.

The first floor of the building, 105x200 ft., is occupied by two stores alongside the main entrance, back of which is a newsreel theater 60x90, reached through a side lobby from 42nd St. The waiting room, 53x135 ft., is one floor above 42nd St. and slightly higher than the 41st St. level; ticket sales booths, baggage room and a lunchroom are located here. Two mezzanines and the penthouse floor are occupied by offices.

From the main entrance on 42nd St., directly under the eagles and lanterns surmounting the building, an escalator and a stairway lead up to the waiting room on the floor above. This entrance, 25 ft. wide by 35 ft. high, is faced with black stainless steel with a map of the world in satin-finish stainless and decorative motifs indicating the important cities of the world in gold stainless—the first use of colored stainless in any important decorative architectural treatment. The exterior of the building as a whole is Indiana limestone.

Modern design is used in the main waiting room and ticket reservation area, metals predominating — nickel, silver, stainless steel and alumilited aluminum.

All public areas are air-conditioned, and several airline offices have independent air conditioning systems. Heating is by steam from New York Steam Corp. pipes. The waiting room is lighted by 32 dome lights recessed in the ceiling, visible only through a 6-in. hole in the ceiling for each fixture; at floor level an illumination of 10 foot-candles is obtained with one 500-watt lamp in each fixture.

Full sprinkling and mechanical ventilation are provided in the two basements that are used by buses. Passenger escalators and baggage lifts serve these basements.

The exterior of the building, designed in modern classic, is large in scale and extremely simple in character. The design was so developed in order that the comparatively small terminal building, with high buildings to east and west and the large mass of Grand Central Station directly opposite, would not be dwarfed by its towering neighbors.

Cutting Down on Pavement Cuts

***Contents in Brief**—Boring where practicable instead of trenching is the practice of a public utility in Chicago's western suburban area when installing gas pipe and conduits under streets, roads, trees, shrubbery and lawns. They use a horizontal earth drill to bore holes from 4 to 14 in., eliminating much pavement cutting. The drill works from a small cut made at the edge of the pavement or lawn, pushing a series of detachable augers through any type of ground except solid limestone.*

USE OF a new horizontal earth drill to install underground lines by a utility company in Chicago suburban areas has greatly reduced the amount of trenching across streets, roads and lawns. The drill, now used wherever practicable, bores a hole in fast time from a small pit dug at the edge of the street or lawn, saving pavement, trees and shrubbery. The utility reports the practice is building up invaluable good will of grateful citizens and pleased public officials.

The drill was developed by Alan Parrish, well-known former highway contractor of Paris, Ill. The type used by the utility consists of two units: (1) the drill rig, containing reduction gears, drive and feed mechanism, all mounted on skids for setting in the hole at drilling level; and (2) a separate gas-engine power unit, swivel-mounted on pneumatic-tired hand truck, which drives the drill through a flexible shaft. The drill rigs are of several sizes, to handle a range of augers from 4 to 14 in., with appropriate power unit for each.

The driving mechanism of the drill rig slides back and forth through a feed length of 4 ft. on a steel bed frame that forms the skids. Feed or travel of the rig is by two hand wheels, one of them worm-geared for slow speed and high power, acting through two small pinions that engage racks on top of the bed frame. The auger fits into a socket connected to the driving head by a flexible chain coupling. At the front end of the bed frame is a detachable collar guide for the auger. The bed frame is anchored in the hole by drift pins driven into the ground.

Alan Parrish has developed and patented two unusual features of the auger: directional control and positive removal of cuttings. Directional control is effected through a 1¼-in. pilot bar, 4 ft. long, tipped with a twisted Carr rock bit. This bar leads the auger through the ground. It is started in true direction by the guide collar on the bed frame. At the back end of the pilot bar is the cutting head, fitted with hardened steel removable teeth

The augers are made up in flights, each 3 ft. 4 in. long, consisting of spiral vanes, welded to extra-heavy seamless tubing. At two points in each flight the vanes are broken: just ahead of each break the vanes are full diameter of the cutting head, elsewhere they are smaller in diameter. The auger flights serve only to transport the cuttings back to the mouth of the hole, they do no cut-

Feed of the auger is by two hand wheels; the top wheel operates through a worm drive for slow speed feeding.

In the left view the drill is boring toward the camera without disturbing the pavement or street traffic, in contrast to the usual trenching operation shown at the right, where the pavement is cut and traffic is blocked.

ting. The full-size sections of vanes keep the hole scoured out, while the broken vanes cut loose any material that may pack in the flights. The auger sections and pilot bar fasten together through hexagon shanks on the lead end that fit into sockets on the trailing end, held by spring keys that permit quick connection and disconnection of the joints.

Recent installation of a new 1½-in. gas line in Garfield Ave., Hinsdale, was a typical example of field practice. This street is in a high-class residential area, and the line was placed in the parking between sidewalk and curb, which contained many fine large elm trees. At each side of cross-street intersections, and at about 100-ft. intervals between intersections, a 3x5-ft. hole was excavated 3½ ft. by pneumatic clay spade as a drilling station.

The drilling cycle was as follows: The crew would lower the drill rig into the hole by hand, then line up the rig for horizontal direction by eye, and for grade by a carpenter's level to check with the surface grade. It was easy to block up one end or the other of the bed frame with wooden blocks and wedges to obtain the desired vertical direction. The bed frame was then anchored by drift pins, the power plant on the surface hooked up and the drill was ready for work in less than 10 minutes.

The pilot bar was started into the ground on the first feed, held in position by the guide collar. Then succeeding flights of augers were added as drilling progressed. Two men operated the machine, one in the hole feeding the drill, adding flights and shoveling out the spoil pulled into the hole; the other man ran the power plant and handed down the flights as needed. The overall average drilling speed was 18 in. per min., including stops for addition of auger sections. To give the pilot bar a chance to cut through boulders and tree roots, a speed of 1 ft. per min. is recommended.

When the drill holed through into the next pit, the feed procedure was reversed, in that the auger line was pulled back and disconnected one section at a time, though the direction of rotation was not reversed.

The gas lines are protected steel tubing in 20-ft. lengths, with all-welded joints. Where the bored hole is fairly shallow, the pipe joints are welded on the surface and the line, which has some flexibility, is shoved into the bore from the surface; elsewhere the joints are welded in the trench.

Portable horizontal drill unit bores holes for underground utility lines, eliminating pavement cuts. Here is the drill rig in action, boring from a small pit and driven by a separate gas power plant on the surface.

In running or very soft ground that collapses as the auger is withdrawn, the pipe sections are fastened to the front end of the auger line and are pulled back into the hole as the augers are withdrawn and disconnected.

When using the large drills, a 4-in. pilot hole is bored first to provide absolute directional control and to make sure no obstructions are in the way. A smooth and pointed 4-in. pilot bar follows the small bore and leads the large auger through the ground. The operator can tell immediately if the drill strikes an obstruction, and from the sound and vibration of the drill, knows whether he has run into an iron or tile pipe, rock or timber.

Alan Parrish, who developed the drill, has organized the Paris Manufacturing Co., Paris, Ill., for production of this product.

Detachable flights are added to the auger line as the bore hole progresses. Preceding the auger is a pilot bar, in view just below the auger sections. In the foreground is the guide collar for starting the pilot bar on a true course.

Preparing the Aggregate for Shasta Concrete

THE 10,000,000 tons of sand and gravel for Shasta Dam concrete is coming (via a 9.6-mile belt conveyor described in the next article) from the banks of the Sacramento River at Redding, Calif., where the contractor has built a washing and screening plant operating as shown in the accompanying flow sheet.

Two walking draglines (140-ft. and 175-ft. booms; 8 and 10-cu. yd. buckets) dig the raw material and deliver it to 42-in. pendulum belt conveyors that supply a 6-in. gyratory jaw crusher from which the product goes to the raw storage pile. Successive lifting by belts with gravity flow through the several processing machines finally delivers the finished product to stockpiles whence belts in reclaiming tunnels lead to the 9.6-mile conveyor system that transports it to the hopper at Coram, the specified delivery point.

Early tests of the aggregate deposit indicated that the two coarser sand grades, about equally balanced, constitute 80 per cent of the fines and that the very fine sand would be only about 20 per cent instead of the desirable 33⅓ per cent. Moreover, some of the sand did not meet requirements in that it broke down considerably in freezing and thawing tests. Hence a slug mill is used in which unsound sand is pulverized and washed away with silt. A rod mill replaces the sand deficiency by grinding coarse sand or crushed gravel.

The specified rate of aggregate delivery is 1,100 tons per hour or 22,000 tons per day (20 hr.), and capacities of equipment at the aggregate plant are arranged to meet that requirement with a comfortable margin. The total quantity contracted for is 7,600,000 tons of gravel and 2,800,000 tons of sand. Rock sizes are 6 to 3 in.; 3 to 1½ in.; 1½ to ¾ in. and ¾ to ¼ in. The three sand grades are hydraulically separated and are of varying degrees of coarseness from No. 4 to No. 200 screen size. There is no definite division line between sizes.

The contract, priced at $4,413,520, is held by the Columbia Construction Co., Inc., Oakland, Calif.; Henry J. Kaiser, president.

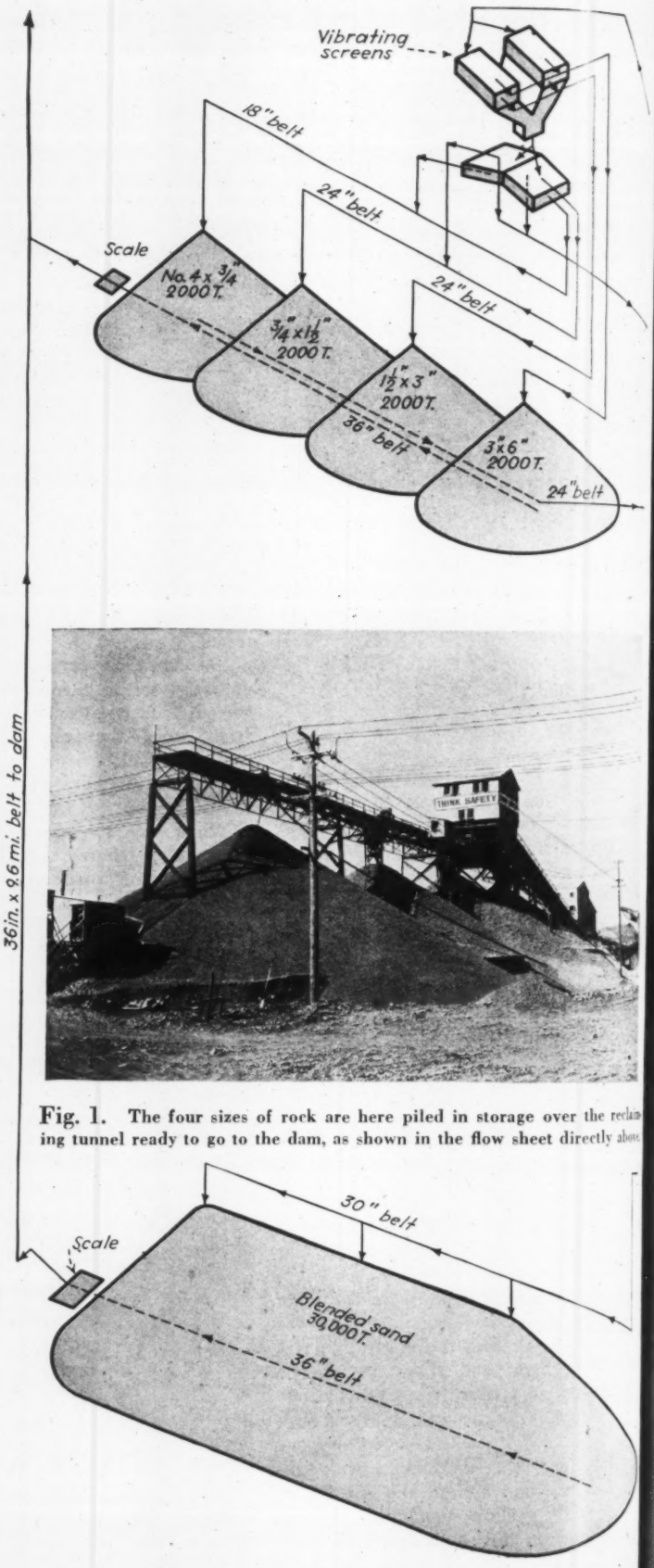


Fig. 1. The four sizes of rock are here piled in storage over the reclaiming tunnel ready to go to the dam, as shown in the flow sheet directly above.

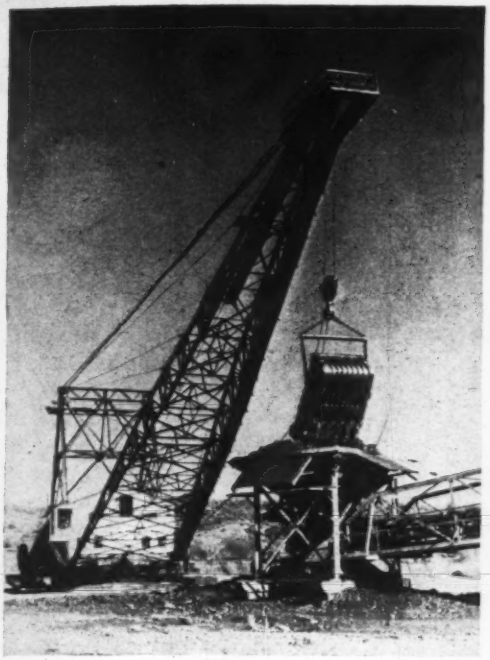


Fig. 2. Walking dragline digs materials from river bank and delivers to a hopper on skids at the end of the pendulum conveyor. This operation is shown on the flow sheet directly below.

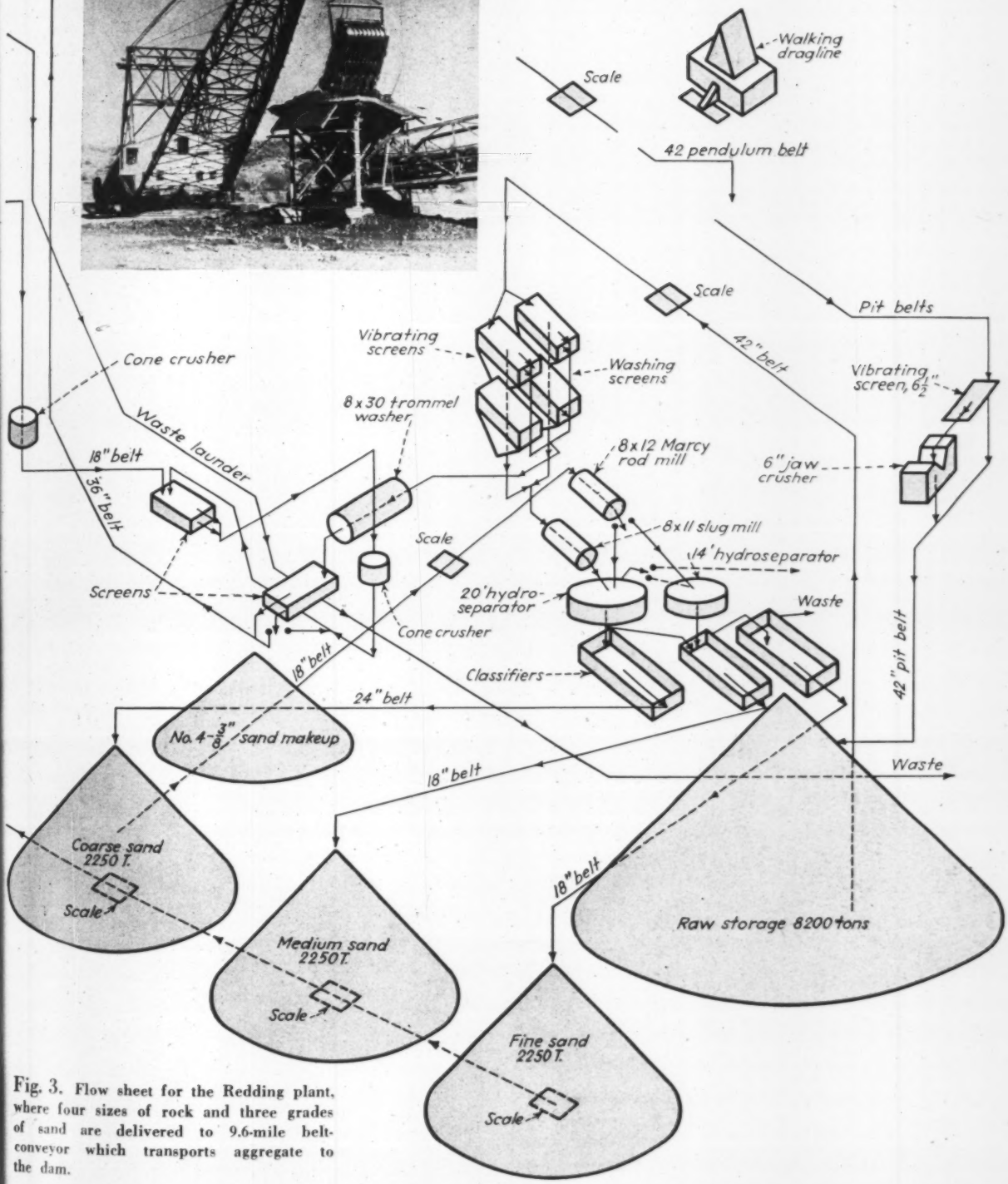


Fig. 3. Flow sheet for the Redding plant, where four sizes of rock and three grades of sand are delivered to 9.6-mile belt-conveyor which transports aggregate to the dam.

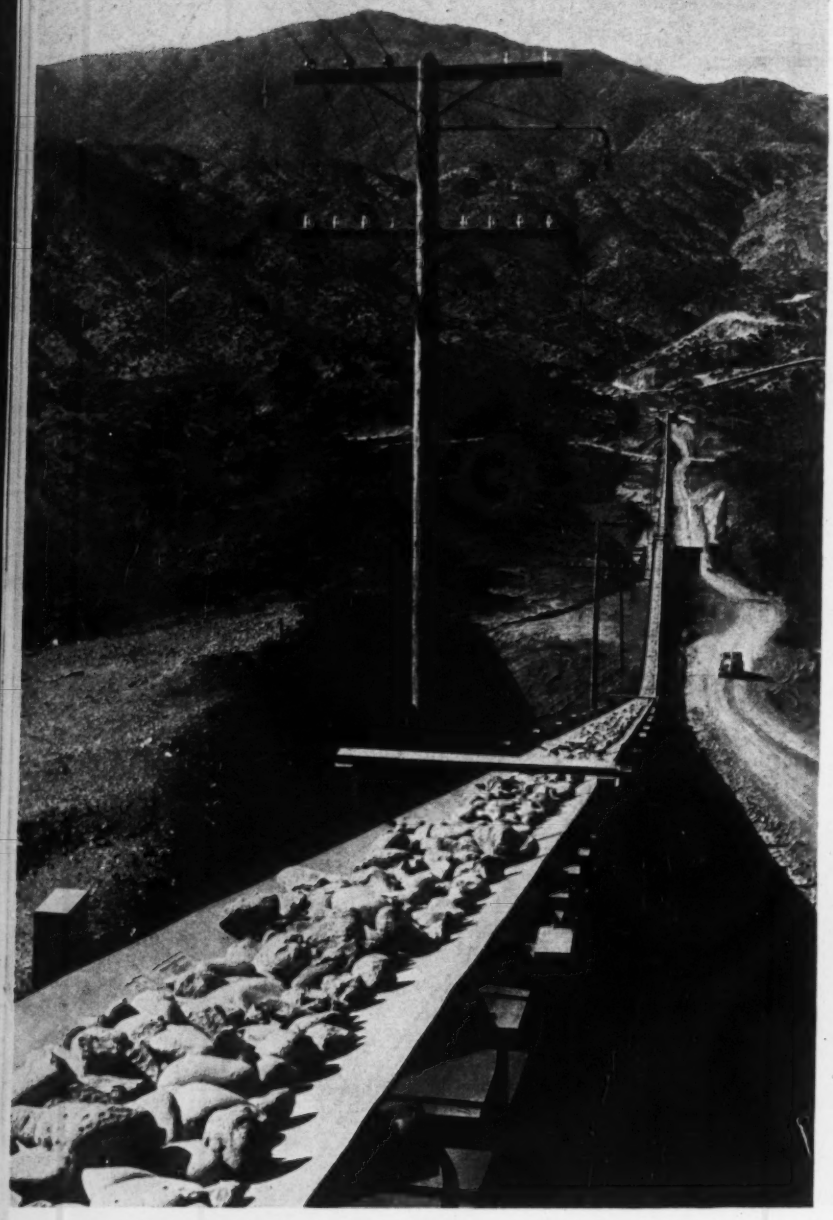


Fig. 1. Typical view of the Shasta Dam belt conveyor supported on timber trestle.

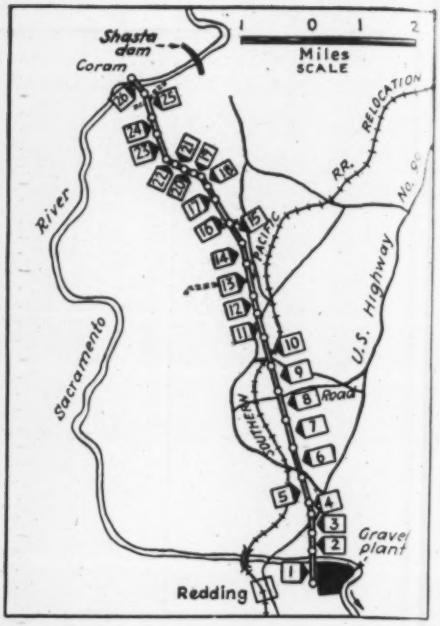
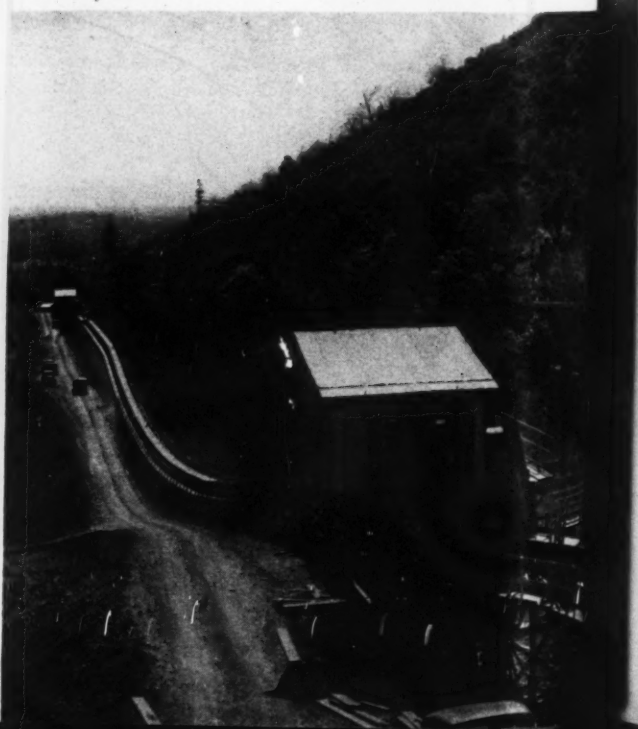


Fig. 2. Alignment of the 9.6-mile conveyor system. The numbers indicate the various conveyor flights.

Fig. 3. The sill for each bent was set at grade; wedges and slotted metal fastenings aided in exact leveling.

Fig. 4. A box beneath the belt protects roads from materials that might spill.

Fig. 5. A typical transfer station along the line. Note the chute dumping on succeeding flight and walkways on both sides of the belt.



Belt Takes Aggregate to Shasta

***Contents in Brief**—Most economical transportation on a 9.6-mile haul for 10,000,000 tons of concrete materials to be delivered to Shasta Dam was found to be by 36-in. belt conveyor system consisting of 26 flights 850 to 3,240 ft. long. Lengths vary inversely with grades which range up to 25 per cent to reach a high point 960 ft. above the loading level. Each flight is designed for a 200-hp motor except on the four downhill flights where regenerative braking is used. Two-way radio in patrol cars facilitates close supervision of operation.*

A NEW RECORD has just been established in length of belt conveyor systems by the 9.6-mile conveyor delivering sand and gravel to Shasta Dam on the Central Valley Project in California. The method was suggested by the contractors to the U.S. Bureau of Reclamation in lieu of rail delivery planned when the contract was signed. The novelty in this installation is primarily in the combination of so large a number as 26 separate flights. To reduce risks incidental to this element and to facilitate speedy attention and maintenance over the entire line, an automobile road was constructed alongside the conveyor, and two-way radio communication was put in the patrol cars. By providing conveyor capacity considerably in excess of that which would be sufficient, in steady operation, to maintain the contracted delivery, the plan is to build up reserves in storage near the dam and thus to allow periods during which the conveyor can be out of service for maintenance or repair. Approval of the belt conveyor plan was announced in *ENR*, Nov. 2, 1939, p. 589.

The elevation at the Kutras gravel deposit in Redding where the belt starts, is 490 ft. From here the conveyor goes in an almost straight line to a high point at El. 1,450 and thence drops down to El. 650 at the Coram delivery hopper. Along this entire 9.6-mile line a 100-ft. right-of-way is cleared of trees and brush as a precaution against fire.

When clearing and grading was being done a roadway alongside the trestle was built for use in delivering materials and for later convenience in patrolling. This road has one 27 per cent grade but this is a downhill for loaded trucks delivering materials.

Relatively little grading was required and most of this is at high points on the line or where it avoided sharp grade changes. Sills for the timber trestle supporting the belt were set at grass-root level when possible except where slight excavation would avoid the need for making extra cuts in framing the bents. The sills were all set by instrument thus smoothing out grade changes and establishing the exact height of each bent.

Except for a few trestles across ravines and bridges over rivers and highways, the belt is kept close to the ground with bents only a few feet high.

The conveyor line includes two crossings of the Sacramento River, one over the main state highway and others over five county roads, four creeks and the main line of the Southern Pacific Railroad. Grades on the belt range up to 13.8 deg. in the up-hill direction, and on the downgrade to 14 deg. or 25 per cent.

Building the conveyor line

Construction of the belt trestle started Nov. 20 with some 200 men, about half assigned to carpenter crews of five men each. Most of the trestle was erected during December and January. Had it not been for a period of unusually heavy rainfall and floods, the work would have been completed March 1. As it was, first aggregate was discharged into the Coram hopper on May 6.

For bents of standard height, timber was precut, bored for bolts and sent out along the line ready for assembly. Gasoline-driven air compressors on trucks supplied power for carpenters' tools operated by compressed air. Carpenters worked to a tolerance of one inch in the predetermined level of the bent caps and, to simplify exact leveling, slotted metal straps were used for fastening bent posts to the sills. To tighten these bolts, wedges were driven between post and sill (Fig. 3) to bring each bent to just the height required. At intervals of several hundred feet a 2x6 extends horizontally across posts projecting upward about 2 ft. from either side of the belt. This has two purposes: (a) it discourages the hazardous practice of riding on the belt and (b) it prevents the belt, when empty, from being blown off the supports in a high wind.

Protection at road crossings

At highway and railroad crossings, box-like receptacles or troughs are built beneath the belt to catch any spillage of material there may be. These troughs have open ends to permit clearing out any accumulations. At one point where the route passes near a school, top and sides of the belt are screened by wire mesh fencing to prevent easy access to it.

A 2x12-in. plank walkway extends the full length of the line; wherever trestle bents are more than 5 or 6 ft. high, the walkway is on both sides and is protected by handrails.

The two Sacramento River crossings as well as the spans over highway and railroad routes are made with light steel trusses, chiefly on steel bents. At the lower crossing of the river economical span lengths figured out at slightly more than 100 ft., with timber crib piers. At the upper crossing, where the narrow canyon makes for higher water velocities, similar spans and concrete piers are used.

The floods that occurred in February carried away all steel spans at the

upper crossing and these had to be replaced with new steel before the belt could be completed. After this flood, concrete in the piers at this crossing was carried up 20 ft. higher, thus encasing the steel bents to a height that is expected to provide protection against future floods and the heavy driftwood carried. At the lower crossing the timber cribs withstood the flood. Even so, to provide more safety against bank cutting in future floods, an additional steel span was added there.

The 26 structures at belt junctions, called transfer stations, house the power drive for each flight and the chutes through which material passes from one belt to the next. These buildings are all supported on concrete piers and so far as possible are located where they are well up off the ground or at least with ample space beneath whence spillage can be removed without hindering operation. No transfer stations were put in cuts.

Power for conveyor operation

The power drive is uniformly a 200-hp motor at the head pulley, and controls for each motor are so interconnected that stoppage of any flight automatically shuts down all others between it and the gravel pit. On the downgrade flights, the generator is operated by the tail pulley, and current generated is fed back into the power line. In the event of power failure while these downgrade belts are loaded, an automatic brake clamps the tail pulley and stops the line until electric power is again available.

Two steel chutes are provided at each belt discharge. One of these, short and steep, serves while the belt is starting up or slowing down during which time the material otherwise would fall, tending to break up large-size cobbles and thus destroy the accurate size proportioning. The second chute is set at a flatter angle to prevent spillage or breakage of large size aggregate at full belt speed.

A pipeline along the conveyor to provide washwater at each transfer station for keeping the belt clean is under consideration. This would be used when needed to supplement the gum wiper on the return side of the head pulley and the V-wiper at the tail pulley.

The belt itself is 36 in. wide, made of 6-ply duck with a $\frac{3}{16}$-in. rubber cover on top and a $\frac{1}{8}$-in. rubber cover on the under side. Designed speed is 550 fpm which was calculated for a delivery of 1,100 tons per hour. As the maximum requirement at the dam will be 22,000 tons per 24 hours, this speed leaves a margin of 4 hr. per day during which the belt should be free for maintenance and repair. The program of operation is to build up a reserve at the delivery end thus providing additional margin. At the outset there is no roofing or covering over the belt. The principal function of such a cover would be to keep rain water out of the fines. However, fines constitute only a small percentage of the total and the plan is to deliver fines during fair weather whenever possible.

Keeping the belt on the rollers

Various devices are used to prevent the belt, when running empty, from riding up out of the trough made by the roller guides. Shims under the roller supports, placed so as to give forward tilt to the inclined rollers, aid in training the belt. Special training rollers of two types are also used, each mounted on a roller frame free to swing around a king pin. In one of these a roller projects vertically above the belt level at the outer edge of the trough. Should the belt edge slip to one side far enough to contact one of these rollers the reaction is to press a brake against the inclined roller on this side. This increased friction tends to rotate the roller frame and thus forces the belt back into the trough. The other type is designed to accomplish the same purpose by frictional resistance set up in a heavily unbalanced idler on the same slope as and just outside the inclined roller. This idler comes into action if the belt runs out of line.

Radio in patrol trucks

A telephone line which connects all 26 transfer stations along the belt can be cut into a 50-watt radio transmitter at the crest of the hill on the belt route. The radio provides two-way telephone communication with sets in the $1\frac{1}{2}$-ton trucks used by the patrolmen. Transmitters in the trucks are of 15-watt power; wave bands are 31,000 and 39,000 kilocycles. Patrolmen away from their trucks and at work on the belt can leave the loudspeakers switched on and thus can be called to the 'phone if within hearing distance. The radio installation complete, including the four stations, cost about $3,000.

Administration

Shasta Dam is being built by the U. S. Bureau of Reclamation; John C. Page, commissioner; R. F. Walter, chief engineer; Walker R. Young, supervising engineer, Central Valley Project, and Ralph Lowry, construction engineer, Shasta Division. The long belt conveyor is operated by the Columbia Construction Co., Henry J. Kaiser, president; S. J. Davis, resident manager. The belt was supplied by the Goodyear Tire and Rubber Co.; and the 17,000 conveyor rollers by the Chain Belt Co. The radio installation for the patrolmen was put in by the General Electric Co.

Fig. 6. Second or upper Sacramento River belt crossing during erection of steel replacing that lost in the February flood. The concrete piers were also raised 20 ft.

Construction Materials Explored by Research

***Contents in Brief**—Much information about the action of materials in service and under test conditions was brought out in papers at the American Society for Testing Materials meeting reported two weeks ago. Leading results are abstracted below. New developments relate to cement, brick, steel, wooden line poles, concrete aggregate and other materials.*

NEW CEMENT SPECIFICATIONS

OUTSTANDING among current developments in construction materials at the recent A.S.T.M. meeting was completion and tentative adoption of a new cement specification covering five types of portland cement: type 1 for use in general concrete construction; type 2 for reduced heat of hydration and increased resistance to corrosion; type 3 for high early strength; type 4 for low heat of hydration; type 5 for sulphate resistance.

Chemical requirements and fineness are specified for the different types, in addition to soundness, time of set, and tensile or (as alternative) compressive strength. The requirements are given in the adjoining table.

An additional important limitation is that after burning no additions shall be made other than water or gypsum or both, "except that not to exceed 1 per cent of other material may be added, provided such material has been shown not to be harmful by tests acceptable to Committee C-1 on Cement." The latter clause modified the requirement adopted a few years ago that the acceptability of admixtures must be determined by tests made directly by the committee.

SATURATION OF GRAVEL

Some gravels used in Missouri highways led to rapid deterioration of pavement although the gravels passed the usual absorption and freezing and thawing tests. Investigation showed that concrete made with stream-wet river gravel deteriorated more rapidly under freezing and thawing than concrete of the same gravel prepared by standard methods (which produce only partial saturation). Soaking the aggregate for 24 hr. after oven drying saturated it to only about 70 per cent of its original moisture content, but evacuation prior to soaking produced a high degree of saturation quickly. The present standard method for freezing and thawing does not positively detect unsound coarse aggregates.—F. N. WRAY and H. J. LICHTEFELD, *Missouri Highway Department.*

VOLUME CHANGE OF CONCRETE

Volume change of concrete due to hydration and the action of internal free water has been studied over a period of years on sealed specimens.

TABLE I.—CHEMICAL REQUIREMENTS.

	Type I	Type II	Type III	Type IV	Type V
Magnesium oxide (MgO), max., per cent	5.0	5.0	5.0	5.0	4.0
Sulfur trioxide (SO_3), max., per cent	2.0	2.0	2.5	2.0	2.0
Loss on ignition, max., per cent	3.0	3.0	3.0	2.3	3.0
Insoluble residue, max., per cent	0.75	0.75	0.75	0.75	0.75
Silica (SiO_2), min., per cent	...	21.0	...	...	24.0
Alumina (Al_2O_3), max., per cent	...	6.0	...	...	4.0
Iron oxide (Fe_2O_3), max., per cent	...	6.0	...	6.5	4.0
Ratio of Al_2O_3 to Fe_2O_3	...	0.7 to 2.0	...	...	0.7 to 2.0
Tricalcium silicate (3 $CaO \cdot SiO_2$), max., per cent	...	50	...	35	...
Dicalcium silicate (2 $CaO \cdot SiO_2$), min., per cent	...	...	...	40	...
Tricalcium aluminate (3 $CaO \cdot Al_2O_3$), max., per cent	...	8	15	7	5

The expressing of chemical limitations by means of calculated assumed compounds does not necessarily mean that the oxides are actually or entirely present as such compounds.

The percentages of tricalcium silicate, dicalcium silicate, and tricalcium aluminate shall be calculated from the chemical analysis as follows:

Tricalcium silicate =
(4.07 × per cent CaO) − (7.60 × per cent SiO_2)
− (6.72 × per cent Al_2O_3) − (1.43 × per cent Fe_2O_3) − (2.85 × per cent SO_3)

Dicalcium silicate =
(2.87 × per cent SiO_2) − (0.754 × per cent 3 $CaO \cdot SiO_2$)

Tricalcium aluminate =
(2.65 × per cent Al_2O_3) − (1.69 × per cent Fe_2O_3)

Oxide determinations calculated to the nearest 0.1 per cent shall be used in the calculations. Compound percentages shall be calculated to the nearest 0.1 per cent and reported to the nearest 1 per cent.

TABLE II.—PHYSICAL REQUIREMENTS.

	Type I	Type II	Type III	Type IV	Type V
Fineness, specific surface, sq. cm. per g.:					
Average value, min.	1600	1700	...	1800	1800
Minimum value, any one sample	1500	1600	..	1700	1700
Soundness:					
Autoclave expansion, max., per cent	0.50	0.50	0.50	0.50	0.50
Time of setting (alternate methods)					
Gillmore test:					
Initial set, min., not less than	60	60	60	60	60
Final set, hr., not more than	10	10	10	10	10
Vicat test:					
Initial set, min., not less than	45	45	45	45	45
Final set, hr., not more than	10	10	10	10	10
Tensile strength, psi.:					
The average tensile strength of not less than three standard mortar briquets composed of 1 part cement and 3 parts standard sand, by weight, shall be equal to or higher than the values specified for the ages indicated below:					
1 day in moist air			275		
1 day in moist air, 2 days in water	150	125	375	...	...
1 day in moist air, 6 days in water	275	250		175	175
1 day in moist air, 27 days in water	350	325		300	300
Compressive strength, psi.:					
The average compressive strength of not less than three mortar cubes composed of 1 part cement and 2.75 parts fine testing sand, by weight, shall be equal to or higher than the values specified for the ages indicated below:					
1 day in moist air			1300		
1 day in moist air, 2 days in water	1000	750	3000		
1 day in moist air, 6 days in water	2000	1500		800	1000
1 day in moist air, 27 days in water	3000	3000		2000	2200

The purchaser should specify the type of setting time test required. In case he does not so specify, the requirement of the Gillmore test only shall govern.

The purchaser should specify the type of strength test required. In case he does not so specify, the requirements of the tensile strength test only shall govern. The strength at any age shall be higher than the strength at the next preceding age. Tests at 28 days on types I and II cement may be waived at the option of the purchaser. If, at the option of the purchaser, a 28-day test is required on type III cement, the strength at 28 days shall be higher than at 3 days.

Some concretes made from normal portland cement show slight expansion for several months, but over a period of years the concrete contracts. Portland-puzzolan cement in most cases contracts from the beginning. In general, concrete may be expected to contract by 50 to 100 millionths in five years; these values are large enough to require consideration in interpreting strain-meter measurements made on large masses of concrete.—HARMER E. DAVIS, *University of California.*

SULPHATE RESISTANCE STUDIES

Five-year exposure tests of concrete cylinders made with 106 cements from 74 mills were carried on in Medicine Lake, S. D. (average 12 per cent total salt, $\frac{2}{3}$ magnesium sulphate, $\frac{1}{3}$ sodium sulphate), and in 1 per cent laboratory solutions of sodium sulphate and magnesium sulphate. The Lake test pieces were compared by their strength ratio to comparison cylinders stored in tap water, while the laboratory specimens were judged by length change.

High resistance to sulphate attack corresponded to low calculated tricalcium aluminate (not over 5.5 per cent), high ratio of iron oxide to alumina (1.0), and high C_4AF. The authors conclude that "A specified upper limit of 5.5 per cent C_3A would come as near to securing cements of high resistance to attack by magnesium and sodium sulphate as reasonably could be expected and would eliminate all cements of low resistance."—D. G. MILLER, and P. W. MANSOM, *U. S. Dept. of Agriculture.*

CORROSION OF PIPES BY WATER

From service data on hot water lines in 17 cities the relation of rate of pitting to time of exposure was determined. Up to 2 yr. there was a wide range in the rate of pitting, while from 2 to 12-yr. exposure the plotted points fell on a definite curve. This would indicate that the initial attack on the metal is a function of the corrosivity of the water, while thereafter the rate of corrosion is slowed down and is controlled by the character of the rust, its porosity and its ability to permit diffusion of oxygen.

Study of the relation between rate of pitting and electrical conductivity of the water showed a consistent relation in six out of eight cities. Two cities gave high rates of corrosion with low conductivity, which could possibly be explained by seasonal variation in the pH of the water.—V. V. KENDALL, *National Tube Co.*

CORROSION OF STEEL

Atmospheric exposure tests of steel and wrought iron specimens continued for 23 yr. have been completed, and seawater immersion tests continued for 12 yr. The atmospheric exposure results confirmed the superiority of copper-bearing steel noted during earlier years. Total immersion gave different results at different locations; high-phosphorus steel made the best showing at Portsmouth but the poorest at Key West. In most of the materials, copper content was advantageous. Open-hearth iron lasted longer than basic open-hearth steel.—COMMITTEE A-5 *on Corrosion of Iron and Steel.*

Comparative atmospheric corrosion resistance of ordinary steel, nickel steel and nickel-copper steel was determined during 15-yr. exposure in various atmospheres ranging from rural to heavy industrial. In the latter the nickel-copper steel proved superior to copper steel, and it also stood up well in marine atmospheres, an exposure to which copper steel was not markedly resistant. In miniature roofing tests carried on for eight years, the copper steels were much superior to bessemer steel, and phosphorus additions were definitely beneficial in the presence of copper.

Steel containing 2 per cent of nickel and 1 per cent of copper was used for part of the bottoms of coal cars, in comparison with ordinary steel. In six years' service the nickel copper steel suffered only about half the loss of thickness of the other steel. It is concluded that the beneficial effect of nickel increases with increase in nickel content; that addition of nickel to copper steels increases their durability; and that addition of copper to nickel steel is beneficial provided the copper content remains somewhat less than the nickel content.—N. B. PILLING and W. A. WESLEY, *International Nickel Co.*

ABRASIVE RESISTANCE OF BRICK

Tests of 50 brick of fire clay and shale with the Kessler abrasion tester showed that abrasive resistance increases with compressive strength and decreases as water absorption increases. The abrasive losses of brick saturated with water were not significantly greater than those of the same brick tested dry.—J. W. MCBURNEY, R. H. BRINK and A. R. EBERLE, *Bureau of Standards.*

MORTAR AFFECTED BY BRICK

A wide range of mortars, from straight portland to staight lime, was tested for volume change due to moisture, for bond and compressive strength, both when the mortar was in contact with brick and when it was molded in metal. The combined packing and suction effect on the mortar in the joints of masonry altered the properties of the mortars, especially those high in lime; mortar in brick masonry showed much less volume change on alternate wetting and drying than mortar molded in metal. To assure high bond it was found important to control the consistency of the mortar so as to assure complete wetting of the brick surface, and to do the final tooling of the joint just as soon as the mortar would stay put. As to strength, lime mortars benefited most by contact with brick. Adding lime to cement mortar may increase the strength of the mortar in brickwork. Bond and compressive strength correlated well in all of the tests.—F. O. ANDEREGG, *Owens-Corning Fiberglas Corp.*

FATIGUE OF GALVANIZED WIRE

In reversed-bending tests, high-strength galvanized wire showed higher endurance limit but lower endurance ratio than low-strength wire. Hot-dip coatings developed hair cracks perpendicular to and terminating at the surface of the steel; electro-deposited zinc coating showed no cracks. The fatigue test detected faults in the wire, such as surface seams or non-metallic inclusions. No correlation could be found between endurance limits and resistance to ordinary bend and twisting tests.—D. G. WATT, *Hydroelectric Power Commission of Ontario.*

Fatigue tests of tire bead wire under pulsating tension applied by a specially designed machine operating at 3,600 cycles per minute showed lower endurance for wire taken from worn tires than for new wire. New bead wire had a range-of-stress endurance limit of 79,000 lb., a wire taken from an unused tire $3\frac{1}{2}$ years old 75,000 lb., and a wire taken from

a 20,000-mile tire 62,000 lb. Rusted bead wires had endurance limits below 20,000 lb. per sq.in.—J. N. KENYON, *Columbia University.*

X-RAYING WOOD POLES

Of the several million wood poles in electric utility services in this country, hundreds of thousands must be replaced each year, principally because of fungus rot near the ground line. Many utilities test their poles periodically by sounding, boring or prodding. X-ray inspection was first tried in 1937, and since then has been shown to have advantages. Radiographs taken with the proper technique, as finally developed, give a good indication of the presence, location and amount of rot. A check on the method was obtained by calculating the probable strength of ten poles after allowing for the amount of rot determined by radiograph, and then testing the poles to destruction; the results agreed within 5 to 38 per cent (14 per cent average), the test breaking load being less in each case than the calculated strength.—MYRON ZUCKER, *Detroit Edison Co.*

EFFECT OF TESTING SPEED

In tension tests of 14 different metals carried out with aid of highly sensitive strain and load measuring devices, the effect of rate of strain proved to be small, except for stainless steel. It is concluded that, for speeds of the testing-machine head below 2 in. per min., doubling the rate of strain would increase the measured yield point and tensile strength by not more than 1 per cent and the elongation and reduction of area by not more than 3 per cent ordinarily, but in brittle cast metals the elongation and reduction of area would be affected much more. In steel the upper or drop-of-beam yield point was most affected by rate of strain.—P. G. JONES and H. F. MOORE, *University of Illinois.*

OTHER A.S.T.M. TEST DATA

In an unusual study of fatigue, C. G. Goetzel and R. P. Seelig (American Electrometal Corp. and Powder Metallurgy, Inc.) found that sintered copper and iron have a lower fatigue limit than cast copper and ingot iron respectively. Fatigue tests of axles by O. J. Horger and T. V. Buckwalter (Timken Roller Bearing Co.) indicated that metal coatings and flame hardening have little effect on the ordinary endurance limits but produce a large increase in resistance under stress concentration resulting from a press fit.

Corrosion-fatigue as affected by protective coatings on steel was investigated by T. J. Dolan and H. H. Benninger (University of Illinois); certain coatings were found to reduce the endurance limit but increased the resistance of the material to corrosion-fatigue failure. J. W. Kenyon found that metallic plating often caused embrittlement or cracks.

Rupture and creep tests at high temperature continued for a year raised question as to the sufficiency of short-time creep tests, according to E. L. Robertson (General Electric Co.). Creep tests of 17 low alloy steels at 1000 deg. F., reported by R. F. Miller, W. G. Benz and W. E. Unverzagt (U. S. Steel and National Tube Co.), indicated that molybdenum, chromium, titanium and columbium have a favorable effect, silicon and aluminum unfavorable effects. Very rapid application of tension at elevated temperatures, investigated by M. Manjoine and A. Nadai (Westinghouse Electric) showed that for soft copper the true stress rises considerably with speed. Strain rates up to 900 per second were used. Sustained loading of ferrous alloys at high temperatures showed, according to R. H. Thielemann (General Electric) that ferritic chromium alloys are the only ones not susceptible to intergranular cracking.

Can Portland Cement Be Improved?

P. H. BATES

Chief, Clay and Silicate Products Division
National Bureau of Standards, Washington, D. C.

Contents in Brief—In the Marburg Lecture before the American Society for Testing Materials, Dr. Bates reviewed the many unknowns in cement constitution and action and pointed to the large opportunities for further study. Admixtures, better processing, new types of kilns, more searching tests, may lead forward to extensive improvement in portland cement. A few extracts from the lecture follow.

UNTIL VERY RECENTLY anyone who would dare propose the use of admixtures with portland cement to improve any somewhat lacking property was figuratively killed with anathemas hurled by some producing interests. Now many of the latter are actively studying the effects of various admixtures as reflected in increased durability. There never have been logical reasons for the peculiar adverse attitude. The first breakdown of this attitude came a few years ago as the result of the marked ability of an organization to demonstrate that one of their products added to the clinker before grinding very materially reduced the cost of grinding.

There is now agitation to permit the use of other admixtures. Some of these have been found most advantageous, according to recent field and laboratory tests, in increasing the life of concrete in highways subjected to "sanding" during freezing conditions with calcium chloride. Most of these are of such a nature that frothing takes place during mixing and consequently as much as 10 per cent or more of air may be introduced into the wet concrete.

There is no reason to assume that improvement in other physical properties cannot be secured by means of other additions. The setting and hardening of cement is a chemical reaction, and all recognize and have before them many examples of marked alterations in reactions induced by the presence of small quantities of foreign materials. We know that the rate of reaction can be materially accelerated by fine grinding of the cement, by heat, and to a less degree by the use of calcium chloride, etc. It does not take much of an imagination to conclude that there are likely a host of other materials which will speed up the reaction tremendously, possibly to the extent that within a day we may have the strength that is

usually attained at the end of a year.

The colloid formed in the setting of cement has the quality of expanding and contracting as the humidity is raised or lowered, to a marked degree. Can we not believe that there are materials—admixtures, if you please—which may so affect the course of the hydration that the resulting products are rendered either irreversible or more stable in respect to other reactive compounds with which they may come into contact during service?

Accepting cements as they are now produced, there seems to be no brighter prospect of improving these throughout their entire life than through the use of admixtures. At this time there is a marked tendency to depart from the high-limed cements to the high-silica ones. These like the low-heat and sulphate-resisting types, unless very finely ground, are also slow hardening. But if this characteristic could be overcome through the use of an admixture acting as an accelerator, we would have approached very closely to the ideal all-purpose cement. There is not much doubt that this accelerator will be found some day—even though for psychological reasons it may not be called an admixture.

Some proposed new tests

The late Thaddeus Merriman proposed a test for determining the resistance of cement to sulphate waters. It may be a good acceptance test for selecting a cement to resist sulphate attack, but unfortunately it has not been subjected to coordinated cooperative trials; there is still lacking the tie-in between laboratory and field.

Merriman also proposed what is generally called the sugar test for cement. Although the test was first proposed about ten years ago, we are still lacking the results of an extended series of tests or observations to correlate the findings in the field and in the laboratory. It does show striking differences between cements which in other respects are the same. It is also generally conceded by producers that cements which will meet this test must be more carefully processed and in some cases quite different mill procedures must be followed than those used for the average cement.

Ira Paul has proposed two tests, a "floc" test and the subjection of clinker fractionated according to certain sieve sizes to an autoclave treatment. It also is an interesting test which shows marked differences between otherwise similar cements, it has not been correlated with field service, and it has not received the openminded attention that it deserves.

T. E. Stanton, in attempting to solve the problem of why so much concrete in a certain section of California gave most inadequate length of life, found that, if the concrete was made of cement containing less than 0.5 per cent sodium and potassium oxides, the results were all that was desired. Much more will be heard about the effect of these oxides, which are present in portland cement in such small quantities that but few analyses show their presence.

Effect of plant processing

Occasionally cements of the same oxide composition and calculated compound composition have distinctly different physical properties. All of the reasons for this are not known. But some of the newly proposed tests and some recent research have shown us some of the reasons; others we can only deduce from analogies with other materials and data.

It has frequently been found that by calometric measurement the heat of hydration differs markedly from that which could be calculated from the composition. Also, cements of practically identical composition have far from identical heat of hydration. Research showed that rapid cooling of the clinker would in many cases result in a cement which has decidedly less autoclave expansion than the same cement slowly cooled. The microscope has confirmed that different conditions give optically different clinker and the ground clinker yields different physical results. It seems quite certain, therefore, that heat treating can produce different qualities of the finished cement.

Producers might well look to other types of kilns wherein the burning and cooling might be more carefully controlled. Granted that the rotary kiln has done so much to develop the industry and to make it possible to market the commodity at the customary low price, it seems well to remember that furnace design of all kinds has materially developed since the advent of the rotary kiln.

Present results satisfactory

It must be accepted that cement technology functions on the basis of uncertainty. But the fact that there are still many uncertainties regarding the true nature of portland cement, how it reacts with water and how it will deport itself under certain trying conditions, in no way detracts from the proven findings of its tremendous use that "the results are startlingly satisfactory."

Water and Disease

Notwithstanding conflicting data which throw suspicion upon present bacterial standards of water quality and the effectiveness of treatment procedures, the marked success achieved by following these standards in reducing the incidence of waterborne disease indicates their practical worth. This was the conclusion presented by George D. Norcom, sanitary engineer, New York, in a report to the American Water Works Association at Kansas City recently.

It is believed that more stress should be placed upon both endemic and epidemic diarrhea which may be transmitted by numerous channels, such as by direct contact or by vectors such as food, milk and secondary water supplies or which may be symptomatic respiratory diseases popularly known as "intestinal influenza." These vectors should be carefully investigated before a water supply is implicated merely because it appears to be the only common factor to a widespread group of cases of gastroenteritis.

In a survey compiled this year with the aid of sanitary engineers in 36 states and 6 provinces, it was noted that a total of 279 outbreaks of intestinal diseases occurred. However, only 44 of these were definitely waterborne, and 55 were suspected to be waterborne. Only 7 of the 44 definitely waterborne outbreaks were transmitted by water supplies whereas 18 of the 58 outbreaks suspected to be waterborne involved water supplies. In general, therefore, it may be stated that public water supplies were not of major importance as vectors of disease.

Delaware Aqueduct—V

Controlling the Flow

Contents in Brief—This article in the Delaware water supply series describes the method which will be employed to control the flow of water through the tunnel. In order to dissipate energy and restrict surge, special precautions were required. This called for the installation of parallel valves to subdivide the flow, and the use of surge chambers and stilling basins. Previous articles appeared in the issues of Apr. 11, p. 513; Apr. 25, p. 584; May 9, p. 656; and June 6, p. 797.

IN EACH MAIN DIVISION of the Delaware aqueduct—the Rondout-West Branch tunnel, the West Branch-Kensico tunnel and the Kensico-Hill View tunnel—the rate of flow will be controlled at the inlet end. In the design of the control three conditions had to be met: (1) dissipate energy without cavitation and erosion; (2) limit surge; and (3) prevent entrainment of air.

In each tunnel when the flow is small (i.e., toward the end of a shutoff, at the beginning of an opening and continuously during the early years of operation when the demand will be but a fraction of aqueduct capacity) friction in the tunnel will use up but a small part of the available head, and there will be a large quantity of energy to be dissipated.

At the Rondout and the West Branch effluent chambers the high heads to be controlled impose the further condition that the control valves shall be either wide open or closed, and shall never be used in a partly open or throttling position which might subject them to cavitation and erosion. This necessitates dividing the flow through a sufficient number of parallel valves so that discharge can be varied by increments small enough for operating convenience and to limit surge.

Changing the rate of flow of the long columns of water in these tunnels will set up surges in the height of the water surface in open shafts, especially the downtake shafts. If at any stage of operation the water should spill into the downtake shaft in the form of a cataract, or if in any other way the entering water should carry entrained air, the air carried down the shaft would tend to accumulate in large masses under the roof of the level parts of the tunnel. Sooner or later this air would escape in huge bubbles up one of the open shafts, blowing up great masses of water and wrecking any structures over these shafts.

Other objections to entrained air include: the increase in pressure in the shaft caps at the tops of the water supply risers if the outlet valves were closed and air should displace the water in the riser; and the undesirable effect of great masses of air entering the distribution system if the shaft cap valves were open to supply water to a neighboring community. The magnitude of some of the basic features involved is indicated by the following table:

Tunnel Designation	Length	Res. elev.	Avail. head
Rondout-West Branch	44.7 mi.	840–503	337 ft.
West Branch-Kensico	22.4 mi.	503–355	148 ft.
Kensico-Hill View	14.0 mi.	355–295	60 ft.

With maximum flow all available head will be utilized; but in any case where the upper reservoir is full and the lower reservoir depleted, heads will be increased.

Solving the problem

While the designs of the control works for the three tunnels are radically different all are based on the following general principles. Surge will be restricted by:

(1) Limiting the speed with which changes in the rate of discharge into the tunnel and in the resulting velocity of the water in the tunnel can be effected. This will be done by subdividing the flow through a number of parallel valves or gates, and by limiting the speed of valve and gate movement.

(2) By providing a surge chamber at the shaft into which the valves or gates discharge, through enlargement of this shaft or otherwise. In the Rondout-West Branch tunnel the top of Shaft 2A is above the highest hydraulic gradient, and it will be utilized as an auxiliary surge shaft.

(3) By the provision of overflows at the tops of the uptake shafts and of the downtake shaft of the West Branch-Kensico tunnel.

Entrainment of air will be limited to the air initially in certain parts of the control works below the control valves by (a) locating the point of discharge into the downtake shaft below the lowest operating tail water level so that the discharge point will always be submerged, even in case of surge; by (b) enlargement of the downtake shaft at the point of entrance of the water to afford low downward velocity of the water and permit escape of entrained air; and by (c) preventing the renewal of the supply of air to any place where air might be entrained.

Excess energy will be dissipated by different methods depending upon local conditions.

Rondout effluent works

A special effluent chamber (Fig. 2) will be used to control the flow into Rondout-West Branch tunnel with 44.7 mi. of water column and a 337-ft. difference in reservoir elevations. The maximum drawdown of Rondout reservoir will be 120 ft.

The water, after passing successively through trash racks, through ports controlled by stop shutters for drawing from four different elevations, and through screens, enters two separate headers. Each header supplies a separate battery of three pipes (two 48-in. and one 54-in.), each pipe with a venturi meter of special design immediately followed by two cone valves in tandem. Each battery dis-

charges into a cylindrical stilling chamber.

The stilling chambers, excavated in solid rock and concrete-lined, are 28 ft. in diameter and about 80 ft. long. To insure submergence of the discharge orifices under all conditions the outlets from the stilling chambers are through the top, at the far end from the point of entrance. The outlet tunnels from the two stilling chambers unite into a single inclined tunnel about 3,200 ft. long, dropping from El. 720 near the stilling chambers to El. 412 at the downtake shaft (Shaft 1). To insure that the outlet of the inclined tunnel into Shaft 1 will be submerged at all times (even during maximum down-surge), the outlet of the inclined tunnel into Shaft 1 was placed at El. 412, which is 91 ft. below the ordinary flow line of West Branch reservoir.

An air vent at the summit of the inclined tunnel will prevent air-trapping at this point, with resulting reduction of discharging capacity.

Double control system

At the intersection with the inclined tunnel Shaft 1 is enlarged, thus serving as a surge chamber and to aid the release of entrained air. The enlarged section is 40 ft. in diameter, tapering above and below to its normal diameter of 14 ft.; the total height of enlargement is 102 ft. The upper parts of Shafts 1 and 2A will act as surge shafts, and since the tops of these shafts are above the highest hydraulic gradient plus surge, they will be vented to the atmosphere. Except for the inclined tunnel the design provides two sets of control equipment which can be shut down separately for inspection or repair.

In the valve chamber one of the two tandem valves will be for ordinary operation, the other in reserve. Massive stop shutters of special design, seating with a heavy rubber gasket on the machined flanges of the bronze wall castings, will make it possible to isolate any single line of piping from the header for the removal of the upstream valve. If all three pipes discharging into one stilling chamber are shut off, either by their upstream valves or by their stop shutters, and if the outlet tunnel from that stilling chamber is bulkheaded, that stilling chamber can be drained to give access to the downstream valves, while the supply is maintained through the other stilling chamber.

The four 48-in. pipes will discharge into their stilling chambers through bronze nozzles of such reduced size as to limit the maximum velocity through the valves to about 30 fps. One of the four nozzles will be smaller than the others, permitting increase or reduction of discharge through these four pipes in seven steps. These four pipes together will supply all ordinary demands, but to obtain the maximum possible discharge through Rondout-West Branch tunnel, the two remaining pipes with 54-in. valves followed by expanding cones, will also be used. Thus, including the 54-in. pipes, control will be obtained in eight steps.

The 54-in. valves which discharge through expanding cones will not be opened until the combined discharge through all of the 48-in. valves has so raised the tailwater gradient in the stilling chamber that velocities through these 54-in. valves will be moderate. Each valve will be either fully open or fully closed; it is not intended that they shall ever be operated in a throttled position. All control valves and sluice gates in this and the other effluent chambers will be hydraulically-operated and limited in speed of travel to one foot or less per minute.

To limit velocity down the inclined tunnel under conditions when this tunnel flows less than full, several methods were considered and subjected to model tests. The adopted method is to greatly increase the wetted perimeter (thus decreasing the hydraulic radius for shallow flows) by a series of longitudinal fins or flume walls in the lower part of the tunnel section. Before the depth of flow materially exceeds the height of the flume walls the tail-water elevation in Shaft 1 will be such that the inclined tunnel will flow full, at moderate velocity, for its entire length. Model tests have shown that the adopted design produces steady parallel flow, without travelling or standing waves or entrainment of air, for all rates of discharge corresponding to the extreme range of rates expected in the prototype.

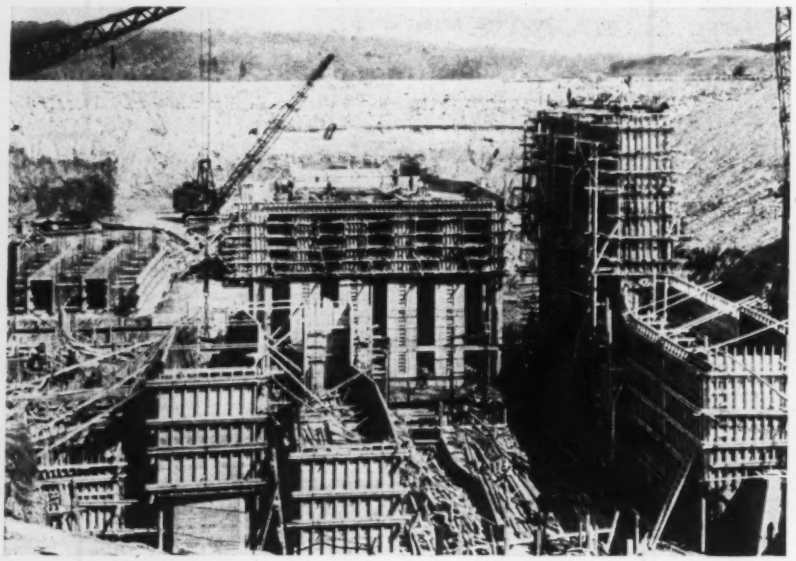


Fig. 1. Kensico South effluent chamber where controls will be provided for the flow of water in the Kensico-Hill View tunnel and through the aerator.

West Branch effluent chamber

An effluent chamber at Shaft 10 (Fig. 3) will control the flow into West Branch-Kensico tunnel, with a 22.4 mi. water column and a 148-ft. difference in reservoir elevations. The water will enter a forebay, either from West Branch reservoir through racks, screens and sluice gates, or from the bypass tunnel. Sills of sluice gates are 34 ft. below the flow line of West Branch reservoir.

From the forebay two groups each of five 48-in. pipes, equipped with venturi meters of the same design as at Rondout effluent chamber and controlled by hydraulically-operated gate valves, will drop down. On each side of the downtake shaft there is one group of pipes carried down to an elevation below the lowest surge in the shaft. The lower ends of these

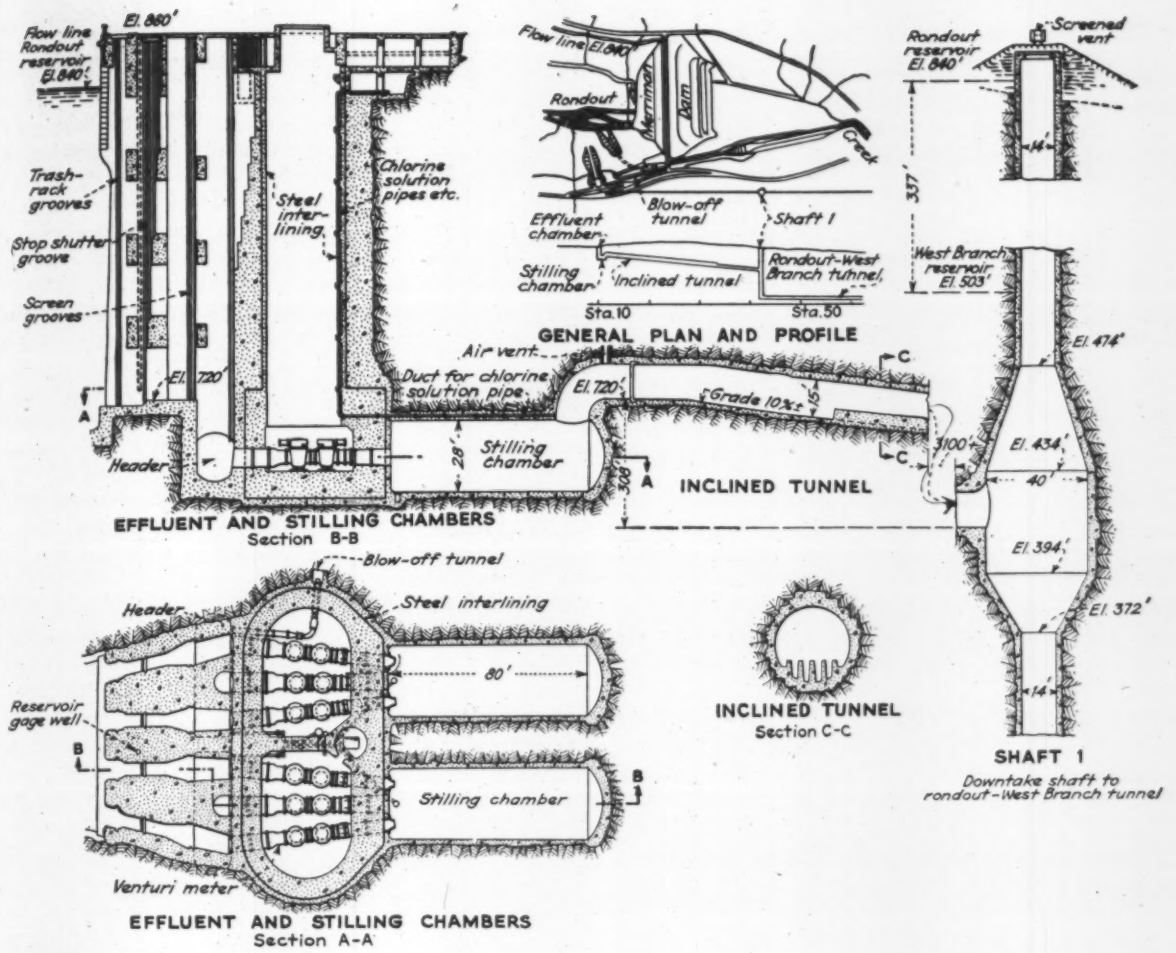


Fig. 2. **Rondout effluent works where the discharge will be directed through two sets of 3 pipes each into separate stilling chambers. For low flows part of the 337 ft. available head will be dissipated by friction in the narrow flumes formed on the bottom of the inclined tunnel.**

pipes will turn slightly upward so that the directions of discharge converge both horizontally and vertically; thus the jets tend to meet at the center of the shaft. These jets will discharge into a stilling chamber formed by an enlargement of the shaft from its normal diameter of 15 ft. to a 44 ft. diameter.

Bronze castings with multiple nozzles on the outlets of these pipes will both limit the velocities through the valves and produce multiple converging and interfering jets for the better dissipation of energy. These nozzles will also offer sufficient resistance to keep the down-pipes full of water under all circumstances, with the valves wide open as they will be operated. Except when only one pipe of a pair is in operation, the pipes will be operated in symmetrically opposite pairs, so that the jets from the opposite sides of the shaft will meet at the center of the stilling chamber.

Below the 44 ft. diameter stilling chamber the shaft will be 40 ft. in diameter for an additional depth of about 35 ft. to afford a low velocity zone for the escape of entrained air, thence tapering to the normal 15 ft. diameter. The total length of shaft enlargement is 105 ft.

Supplementing the ten pipes for conditions of maximum draft, two rectangular gate valves each 4.5 by 5 ft., discharging directly from the forebay into a surge-and-stilling chamber at the shaft head can be used. However, these will be used only when the discharge through the 10 pipes has built up the tail water in the shaft to above the sills of these valves, so that these valves will always discharge submerged. The ten 48-in. valves and two rectangular gate valves will permit varying the flow by 11 or 12 increments without throttling any valve.

Unlike the Rondout effluent chamber there will be only a single valve in each discharge pipe. Guard valves are not necessary since the maximum head on the valves will be only about 45 ft. Access of water from the forebay can be shut off by stop shutters, and except with the largest flows the water in the shaft will stand lower than the valves. Therefore, any valve can be removed in the dry when its stop shutter is in place.

The main features of this design are based on hydraulic model tests made at Worcester Polytechnic Institute to determine the size and efficiency of the stilling chamber and the efficiency of various types and arrangements of jets.

Kensico effluent chamber

The Kensico South effluent chamber (so named to distinguish it from the adjacent Kensico effluent chamber of Catskill aqueduct) is at Shaft 18 and will control the flow in Kensico-Hill View tunnel. Here conditions are much less difficult than at Rondout

and West Branch, the length of water column affected by surge being but 14 mi., with an intermediate filter-connection chamber at Shaft 19 which will act as a surge chamber; the normal difference of reservoir elevation is but 60 ft. Furthermore, in normal operation about 16 ft. of this head will be used up in aeration, and when filters are built at Shaft 19 about 10 ft. additional head will be used for filtration.

Under usual conditions of operation the water will enter a forebay in this chamber directly from Kensico reservoir, passing successively through (1) trash racks; (2) stop shutters permitting draft from three depths; (3) traveling screens; and (4) five 6- by 15-ft. sluice-gates with their sills 53.5 ft. below Kensico reservoir flowline. Three 6- by 12-ft. sluicegates will control water drawn into the forebay from the Kensico Bypass tunnel. From the forebay the water will pass either to the aerator or to a shaft-head chamber feeding into the downtake shaft.

Flow to the aerator will be controlled by ten 5- by 8-ft. sluice gates each feeding a separate conduit and a separate group of aerator nozzles. Flow to the downtake shaft will be through one or more of three pipes controlled by 60-in. cone valves and discharging directly into the shaft, supplemented by two 5- by 15-ft. sluice-gates discharging into the shaft-head chamber. The pipes from the cone valves will discharge below the control effected by the gate sills at the filter connection chamber at the next downstream shaft.

The ten sluice-gates feeding the conduits to the aerator permit changes in rate of delivery by 10 steps, each gate being always fully open or fully closed, never being used in a throttled position. When feeding direct to the downtake shaft without aeration, the three cone valves (which may be used for throttling), either or both sluice gates (which will be operated fully open) or any combination of these valves and gates, will provide the desired gradation of flow. The aerator will be further described in a subsequent article.

Surge will be limited by the slow and gradual changes of flow made possible by the cone valves, by the shaft-head chambers at the Kensico effluent chamber acting as surge chambers, and by the considerable surge chamber effect of the large gate house provided for the connection to future filters at Shaft 19.

The Kensico South effluent chamber will be the largest control chamber of the Delaware system, the substructure measuring 172 by 148 ft. in plan, excluding certain details accessory to the aerator. The maximum inside depth, to the bottom of the shaft-head chamber, will be 93 ft. below the flow line of Kensico reservoir (El. 355) and 103 ft. below the superstructure floor (El. 365). For controlling the flow of water this chamber will contain three 60-in. cone valves and 25 sluice gates.

Venturi meters

The venturi meters at Rondout and at West Branch effluent chambers will be of a condensed type, with the usual conical section between the upstream pressure ring and the throat replaced by a much shorter reducing fitting having walls of a profile ap-

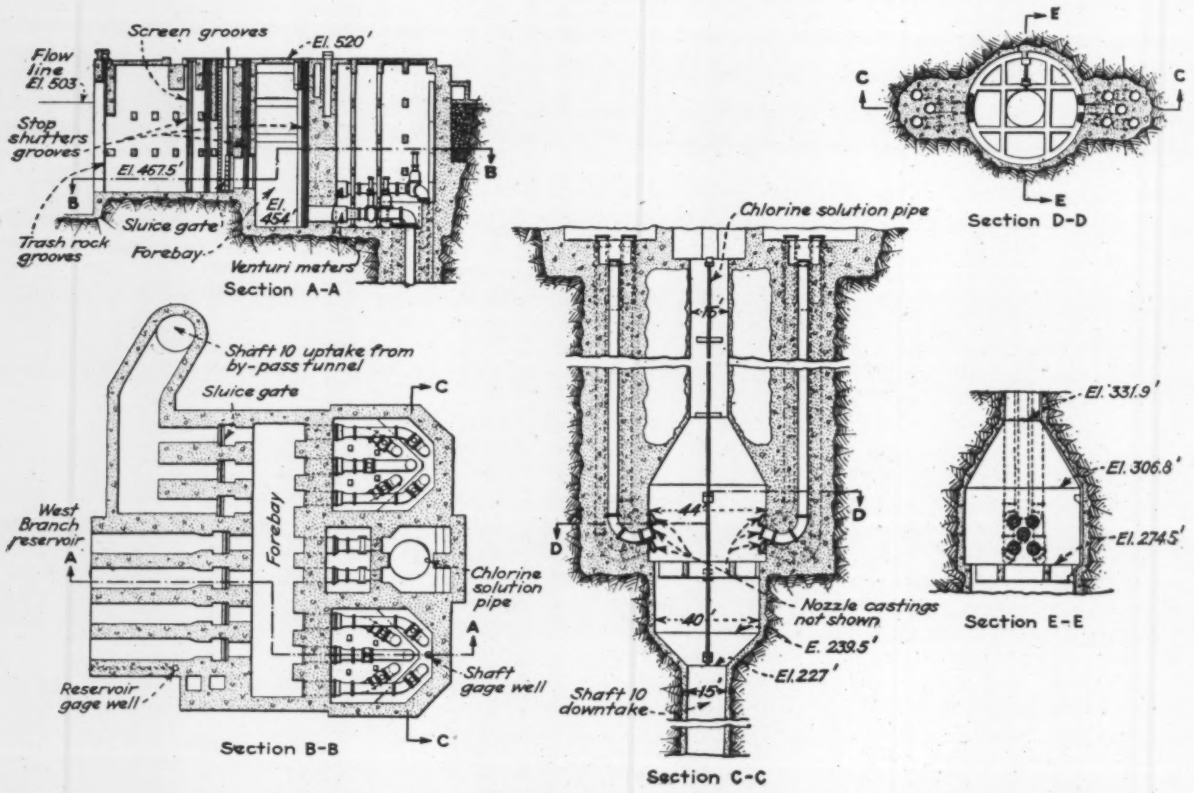


Fig. 3. West Branch effluent chamber where the discharge will be through five pairs of opposing pipes arranged so that opposite jets impinge at the center of the enlarged shaft. Each pipe will terminate in a nozzle casting, producing multiple converging and mutually interfering jets.

proximating the quadrant of an ellipse. In each case the throat will be of the same diameter as the controlling valve downstream from the meter; except in the case of the two 54-in. valves at Rondout effluent chamber there will be no downstream expanding cone for the recovery of head.

In each of these chambers each meter will be equipped with an individual rate-of-flow indicator. In addition, the combined flow of all the meters will be mechanically totalized by a master recorder which will include a rate-of-flow indicator, a continuous counter, and a 24-hr. rectangular chart on which will be traced the combined rate of flow, the cumulative delivery through all meters since the beginning of the 24 hours, and probably the elevation of the water in the reservoir.

At Shaft 10 this totalizing will be done separately for each group of six meters.

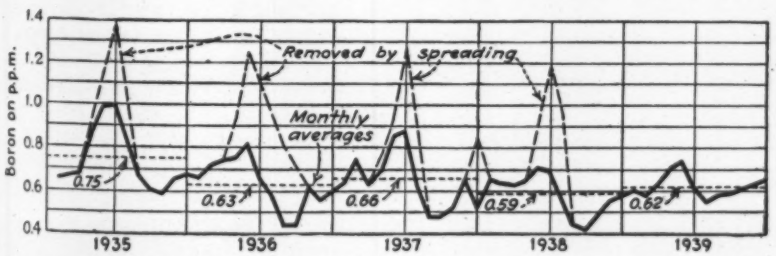
At the Kensico South effluent chamber there will be a single venturi meter, 18.5 by 12 ft., in the downtake shaft. In this meter, also, the waterway upstream from the throat will be of quarter-elliptical profile but there will be the usual expanding cone for the recovery of head downstream from the throat. The recorder for this meter will have the usual rate-of-flow indicator dial, chart and counter, and will record the same information as the charts at the other effluent chambers.

Boron Creates Special Problems in Los Angeles' Water Supply

Contents in Brief—Boron may be seriously harmful in irrigation water at concentrations far less than those permissible in potable waters. Methods developed for greatly decreasing the boron in water from Owens Valley, supplying Los Angeles, so that citrus orchards can be irrigated safely.

TEN YEARS AGO the leaves of citrus trees in certain Los Angeles orchards turned yellow and dropped off, and there was greatly decreased production. Various possible causes of the phenomenon were studied without success until attention was turned to the water used for irrigation. This came from the city's Owens Valley aqueduct and was not suspected at first because for 15 years it had been used with no bad effects. However, analyses and experiments showed that boron was present in the irrigation water and that this element was responsible for the yellowing and dropping of the citrus leaves.

The situation was serious because survival of the important citrus industry in the region dependant on Owens Valley water was at stake. Hence intensive study was begun to determine (1) what boron concentration would injure the trees, (2) where the boron came from and (3) how it could be controlled. The investigations were quite successful, and methods of control now used include, first, the bypassing and wasting of the aqueduct flow for a week or two each year at times of maximum boron runoff, and, second, spreading waters of high boron content on unused land near the source of supply, thus causing boron to become concentrated in the soil by a leaching process and permitting filtered water to be pumped from wells located some distance away from the point of spreading.



Average monthly boron content in Los Angeles aqueduct water at upper San Fernando power house.

Some facts about boron in its effect upon plant growth need to be stated to make the control problem understandable. Most of these were developed by the U. S. Department of Agriculture, chiefly in the Rubidoux laboratory at Riverside, Calif. In spite of a decade of study, however, there are still many unknowns in the subject; just how much boron is needed by different crops and what concentrations are injurious to them are not yet exactly known; nevertheless the available knowledge has brought about the establishment of a definite policy in handling the water to Los Angeles from Owens Valley.

There are two outstanding facts: (1) the principal irrigated crops under consideration all require some boron (which they must get either from the soil or through the irrigation water) in order to thrive at all, and (2) some crops, particularly citrus, avocado and tropical trees, are injured by too much boron.

Upper and lower limits of boron differ widely for different plants; some plants require an amount that would injure others. The range between permissible upper and lower limits is small for some crops and large for others.

For example, sultana grapes show deficient growth and crop production when the boron content of water supplied them is as low as 0.05 ppm; they grow best with 1 ppm of boron, and are severely injured when the boron reaches 5 ppm. On the other hand, date palms show deficient growth when the boron is at or below 5 ppm and will tolerate concentrations up to 100 ppm. For citrus fruits the minimum of boron needed for good growth is unknown but it is now known that boron becomes injurious in quantities of 0.75 ppm.

Various factors other than boron content in irrigation water are involved, for example, soil texture, sulphate content, drainage, fertilization, and the use of boron-containing

sprays used in pest control. The sulphate radical appears to act detrimentally with boron; it is doubtful which actually does the damage and which is just the catalyst. Because of these and other complicating factors, the ideal concentration of boron water cannot be stated for all conditions.

From all the studies it was concluded that if the boron in the Owens Valley supply could be kept below 0.75 ppm, the water would be safe for citrus irrigation, a great deal of which is done with this water supply. The quality of the water for drinking purposes was at no time in question, as boron in potable waters may run as high as 30 ppm without quality impairment.

Source of boron

A study of boron sources in the Owens Valley was continued over a period of years. It was found that no boron entered the aqueduct below Haiwee Reservoir, and that most of it originated from localized points in Long Valley. It was established that during the summer irrigation season in San Fernando valley, 75 per cent of the boron content in the aqueduct water was contributed by the Hot Lake area in Long Valley, 15 per cent by Hot Creek, and only 10 per cent by all the other sources combined. Boron contentration increased at points where hot gases and hot water containing boron bubbled up through lakes and springs.

Control by bypassing

Operation of this aqueduct, as in others of considerable length, has required that it be taken out of service from time to time so that repairs could be made. These shutdowns frequently could be arranged for times when the boron runoff was at its peak by reason of flood flows from the area of heavy boron contribution. Thus the excessive boron was discharged into Owens Lake which is not a source of potable water. In this way, as much as 300 tons of boron per year has been kept out of the aqueduct.

Boron control by leaching

After the boron sources were located, a simple but highly successful expedient was devised which has been used ever since to limit boron concentrations in aqueduct water. The waters containing boron are simply spread over land formerly irrigated but now abandoned, and there allowed to percolate into the ground. At some distance downstream the groundwater comes to the surface naturally and can be pumped from wells to augment the aqueduct supply. Water thus percolating through the soil loses so much of its boron by filtration that when pumped from the wells almost none remains.

Completion of the Long Valley Dam will put a stop to use of the lower spreading grounds where high boron waters have been separated from good waters and filtered. This will affect the waters from the gassy zone in the Hot Creek region particularly. The new program will be to convey aqueduct water through this danger zone in a tight 1,300-ft. conduit.

Likewise, the Hot Lake area will be drained and water of high boron content will be evaporated or spread on land nearby. Exclusion of boron by these means is expected to reduce the normal boron content to 0.33 ppm, and to keep the monthly boron peak in summer (the irrigation season) below 0.46 ppm.

By such control methods and by the dilution obtained through the addition of the Mono supply (which has a negligible boron content) it is expected that the average boron concentration in the water supply brought from Owens Valley will be held down to 0.22 ppm, and the maximum monthly content to 0.33 ppm, a limit that is expected to meet all irrigation requirements. Before control methods were adopted the maximum boron content during summer months frequently reached 1.5 ppm.

Water Power in Canada

WATER POWER RESOURCES of Canada total 20,400,000 hp under conditions of minimum flow and 33,700,000 hp with flow ordinarily available for 6 months of the year, according to the annual review of the Dominion Water and Power Bureau. This figure indicates a potential turbine installation of about 43,700,000 hp. The total actual turbine installation is 8,300,000 hp as of Jan. 1, 1940, or slightly less than 19 per cent of present recorded resources.

Canada's water power resources are favorably distributed near industrial provinces and pulpwood and mineral supplies. Water power of the Maritime Provinces, though relatively small, is a valuable economic resource, supplemented by nearby coal supplies. Quebec's water power resources represent 49 per cent of the total for Canada. The Hydro-Electric Power Commission, Ontario, operates more than 65 per cent of total hydraulic installation of the province, serving 825 municipalities. In the Prairie Provinces, Manitoba has the greatest power resources and the greatest development, 72 per cent of the resources of all three provinces being on the Winnipeg River. Southern Alberta and southern Saskatchewan, with least water power, have large fuel resources. The considerable water power of the Yukon and Northwest Territory is so remote from markets as to limit its present commercial development to local mining uses. About 60 per cent of total available water resources and more than 80 per cent of developed water power are located in Ontario and Quebec.

New water power installation in 1939 totaled 97,040 hp. The report lists utilization of Canada's 8,300,000 hp as follows: central electric stations, 7,300,000 hp, or 87.9 per cent of total; pulp and paper mills, 650,000 hp, 7.9 per cent of total; other industries, 350,000 hp, or 4.2 per cent of total. Average installation per 1,000 population is 733 hp.

Of all electricity generated by the central electric stations 98 per cent is sold in Canada. The pulp and paper industry bought from the central electric stations in 1938 about 47 per cent of all industrial power sold. The mining industries generate or buy about 1,000,000 hp per year. Diversified industries maintain hydraulic installations of 350,000 hp and purchase more than 53 per cent of all industrial power consumed in Canada.

Water power installation has grown from 143,000 hp on Jan. 1, 1900, to 8,300,000 hp on Jan. 1, 1940. In the same period central electric station installation has increased from 48,000 hp to 7,300,000 hp, or from 33.5 to almost 88 per cent of the total. Water power investments total $1,665,000,000.

FROM FIELD AND OFFICE

Working problems and time-saving methods for engineers and contractors

A Shop Hoist in the Field

W. H. BANTHIN
Oak Park, Ill.

The subcontractor for fabrication and erection of the steel floor system in a 4-story, 8-building FHA approved apartment project found it necessary to develop an economical method of storing, transporting, hoisting and erecting the fabricated steel floor panels.

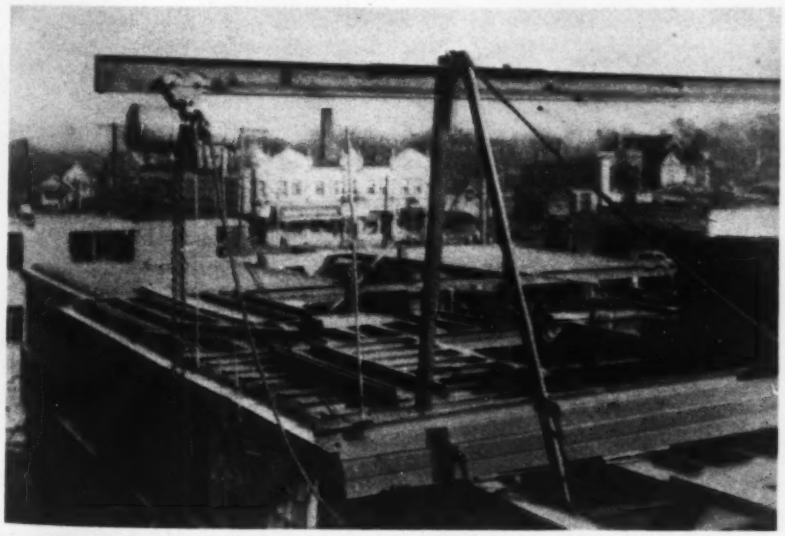
Shop fabrication consisted of forming mill-cut sheets of steel to the predetermined cross-section, welding on the beam clips and storing in proper sequence for field delivery. After a study of each building's floor layout each panel type was coded for a definite location and grouped together to make up a definite lift of from 20 to 30 panels. As the panels were shop-fabricated each group was made up into a nested stack on sections of 4x4 timber blocking in and under the crane bay. As necessary for delivery to the field each stack was clamped together by two ½-in. rods, a channel base plate and eye-hold top channel. Into the top channel was placed the shop crane hook, and the entire stack was transported to trucks at the dock.

On the job the trucks backed up or pulled alongside a given location where a shop 1-ton chain hoist rigged with a monorail and supporting bents picked up the stack of nested sections and easily hoisted them to the working floor. This monorail hoist was erected at two locations for each building as each floor became ready for floor panels and provided ample hoisting capacity to keep in sequence with the other trades. When in use the steel bents of the monorail were anchored to the principal structural members by special clamps. On account of extensive electric welding used on the project 220-volt 3-phase power was available for the hoist.

BRIEF MEMORANDA

Mud and dirt carried into construction offices creates an unusual dust nuisance. A cheap and effective sweeping compound can be made of sawdust from the carpenter shop and pale paraffin form oil. Use sufficient oil in the sawdust to form a ball but not enough to drip. The supply for several weeks can be made at one time. If the floor is dry leave the oiled sawdust down overnight a few times and a perfect oiling job will result without the usual slipperiness of oil applied directly. At first the floor will be speckled but it will soon attain a uniform dustless surface.

When he found the boiler he had been using to flush snow out of the forms for the Federal Office Building in Washington would not deliver steam to the upper floors, Hugh Gibson, superintendent for McCloskey & Co., twisted three lengths of water pipe into a rough coil. Building a bonfire in two old wheelbarrow bodies, he put the coil in the fire, attached one end to the cold water line and got excellent delivery of hot water and steam.



Chain hoist trolley rail saves time on building work.

FIELD & OFFICE COMMENT

Information Please

Sir: Am enclosing a rather interesting snapshot of a portion of an adobe wall, wrecked in the recent quake at Brawley, California.

The wall is approximately two feet in thickness, with a concrete coping 4 in. thick by about 30 in. wide. The reinforcing in the coping consists of two ½ in. round bars about 16 in. apart, at the bottom of the slab.

In the view shown, the wall had collapsed toward the rear, leaving the coping suspended. The clear span of the coping is approximately twenty-five feet, and the deflection at the center about three feet. At the nearer end of the span, the slab is resisting a considerable negative moment, as is evident from its curvature. There are no cracks or breaks visible in the concrete, and apparently this enormous deflection is caused by elastic deformation alone. If this is the case, will someone kindly figure the concrete and steel stresses?

GEORGE W. MILLER
Structural Engineer
Glendale, Calif.

BOOK NOTES AND REVIEWS

The month's additions to the engineer's reading and reference list

Bay Bridge Report

SAN FRANCISCO-OAKLAND BAY BRIDGE: Sixth Annual Report—By Charles H. Purcell. Published by The California Department of Public Works, San Francisco, Calif.

The sixth Bay Bridge report, in addition to statistical information, contains an account of the completion of construction of the bridge railway, construction of additional facilities, operation and maintenance and refinancing. Its engineering reference value lies largely in appendices that outline the triangulation methods, describe the geology of the foundations, and give details on the insurance carried, in addition to information on traffic, tolls and painting. A new method of steam cleaning the surface of steel in preparation for painting is described. With this report the record of construction of the bridge is concluded. Of the five preceding volumes, the first three covered legislation, financing and construction, the cost, completion and operation of the highway bridge and beginning of construction of the bridge railway, and the fifth railway construction progress and highway operation and maintenance.

Surveying Texts

ROUTE SURVEYING — Second Edition. By George W. Pickels and Carroll C. Wiley. 427 pp. Published by John Wiley and Sons, Inc., New York. Price $3.50.

ELEMENTARY SURVEYING—First Edition. By Warren C. Taylor. 236 pp. Published by International Textbook Co., Scranton, Pa. Price $2.

Degree of curvature definition is revised, spiral curves are made more readily understood, and a new chapter on string-lining is included in the second edition of "Route Surveying." An arc definition of the degree of curve has been adopted in place of the chord definition previously used by the authors. This arc definition provides a constant relation between the radius and the degree of curve which is exact for all curves. In the spiral chapter, rate of curvature, rather than length of curve, is used as the controlling factor. Spirals for highways are treated fully.

Although the string-lining method of realigning existing railroad curves has been in use by the railroads for many years, the authors of "Route Surveying" state that this is the first time the subject has been treated in a college textbook.

Professor Taylor's book is a text on elementary surveying which admirably achieves its purpose of giving a foundation of surveying knowledge to all engineering students, whether they be mechanical, electrical, civil or any other brand. The author has resisted any temptation to include material that might be of interest to advanced students, but which might confuse the picture for the beginner. After a brief historical sketch, the first principles of surveying are discussed (chaining, leveling and traversing). Beyond these fundamentals is given an understanding of the various kinds of surveying and mapping with which any engineer might have to deal.

Largely Pictorial

THE PAN-AMERICAN HIGHWAY—By Harry A. Franck and Herbert C. Lanks. 247 pp. Published by D. Appleton-Century, 35 West 32nd St., New York, N. Y. Price, $5.

There is little in this book about the engineering work involved in building a highway through Mexico and Central America to the Panama Canal, but for those who are interested in the character of the country through which the highway runs, the conditions to be met, and the type of people it will serve, no better source could be found than the pictures and text that are presented.

All About Water

INDEX, 1881-1939, to the Proceedings, Journal and Other Publications of the American Water Works Association. 285 pp. Published by the association, 22 East 40th St., New York. Price $2, members $1.75.

What was said about water, by whom, and when, in the 59 years of publications issued by the American Water Works Association, can now be answered quickly with the aid of the index just issued by the association. This book gives a chronological listing of all published papers — grouped under 70 major subjects of the waterworks field. Some subjects are further divided for the reader's convenience. Besides a complete author index, the book also includes a useful guide to the topics in the subject index and descriptions of publications issued by the association or in cooperation with other organizations.

MISCELLANEOUS NOTES ON BOOKLETS AND REPRINTS

A LISTING OF STATE HIGHWAY OFFICIALS has been prepared by the American Road Builders Association, National Press Building, Washington, D. C., under the title State Highway Information. It includes the principal engineers of each state highway department as well as the titles of the officials charged with purchasing equipment. It sells for $1.

PAMPHLETS ON AIR-RAID SHELTERS, published by the British Government, may be obtained from the British Library of Information, 15 Rockefeller Plaza, New York N. Y. These include "Domestic Surface Shelters," which sell for 10 c. and "War-Time Building Bulletin No. 1," (30 c.). The library also has available lists of other publications relating to air-raid precautions.

TEN CHARTS giving building-code span limits for Douglas fir joists and rafters under the California code have been published by Ernest Irving Freese, 6247 Pinecrest Drive, Los Angeles. Price, $1.

HIGHWAY SAFETY INFORMATION covering a wide field has been assembled by the Automatic Safety Foundation, Power Building, Washington, D. C., in a pamphlet entitled "Highway Safety Digest," following closely the form of the *Readers' Digest.*

ROCHESTER (N. Y.) has submitted to the citizens of the city its second annual report entitled "Rochester's

(Continued on p. 82)

GIANT POWER CONCENTRATED

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IN an Exide-Ironclad Battery for a locomotive or trammer, you get truly giant power. It is power that can move greater tonnage because it means consistently higher haulage speeds day in and day out. It is power that handles heavy loads with ease, delivered in a great surge if necessary for unusual loads and grades.

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(Continued from p. 80)

Government". Largely graphic in its form, the pamphlet gives the average citizen an understanding of the work of his city government that cannot be obtained from any statistical report.

A COMPARISON of the breakdown of road aggregates under a road roller with results obtained in determining the qualities of the same aggregates in a "Los Angeles Rattler", a paper by T. E. Shelburne before the American Society for Testing Materials, has been reprinted as Circular No. 20, Degradation of Aggregates Under Road Rollers, National Sand and Gravel Association, Munsey Bldg., Washington, D. C.

NEW ENGINEERING BOOKS

CIVIL SERVICE MANUAL—By Sidney Alten. 164 pp. Published by Foundation Books, 105 West 40th St., New York City. Price $2.

ENGINEERING SURVEYS—By Harry Rubey, George Edward Lommel and Marion Wesley Todd. 2nd Edition. 321 pp. of text, 107 pp. of tables. Published by The Macmillan Co., 60 Fifth Ave., New York City. Price $3.50.

GOVERNMENT AND ECONOMIC LIFE—Vol. II., 1301 pp. By Leverett S. Lyon, Victor Abramson and associates. Published by The Brookings Institution, 722 Jackson Place, Washington, D. C. Price $3.50.

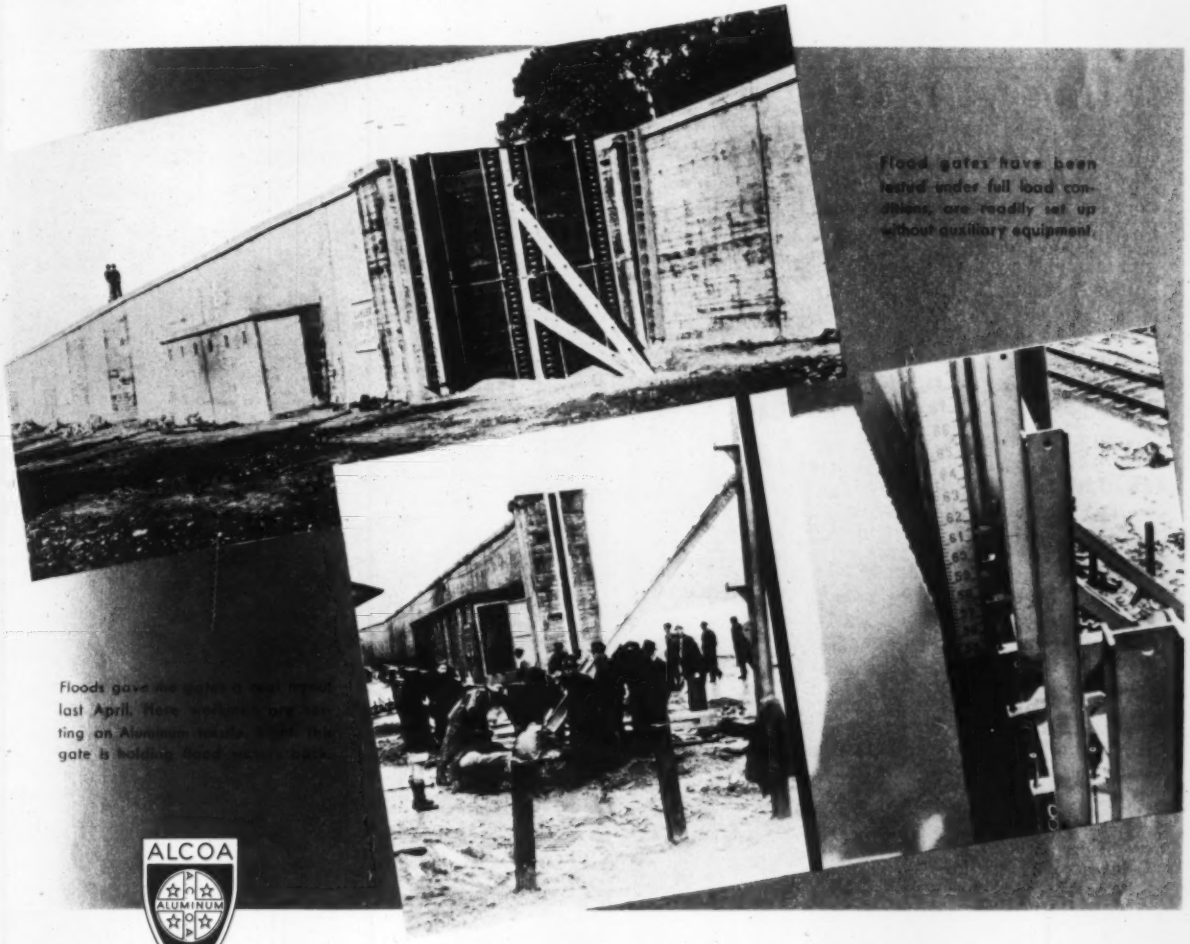
INDEPENDENT LABOR ORGANIZATIONS AND THE NATIONAL LABOR RELATIONS ACT—By Frank T. Bow. 120 pp. Published by Prentice-Hall, Inc., 70 Fifth Ave., New York City. Price $2.

REPORT ON THE WATER RESOURCES OF TRANSJORDAN AND THEIR DEVELOPMENT—By M. G. Ionides. 352 pp. and maps. Published by the Crown Agents for the Colonies, 4 Millbank, London, S.W. 1. Price 30s.

SOUND TRANSMISSION IN BUILDINGS—By R. Fitzmaurice and William Allen. 48 pp. May be obtained from the British Library of Information, 50 Rockefeller Plaza, New York City. Price $1.20.

GEOLOGY FOR CIVIL ENGINEERS as Applied to Highway Engineering—By D. G. Runner. 299 pp. Published by the Gillette Publishing Co., Chicago, Ill. Price $5.

There are *no weak links* in these FLOOD PROTECTION WALLS



Floods gave the gates a [illegible] last April. Here workmen are setting on Aluminum needle [illegible] the gate is holding [illegible]

Systems of walls now protect Huntington, Kenova, and Ceredo, West Virginia, against floods. The gates, usually the most vulnerable points, can be quickly and securely sealed by timber stop-logs stored at each location.

Portable Aluminum Alloy trestles, designed by the U. S. Engineers Office, Huntington, W. Va., support these stop-logs. Vertical members, eight to twenty-one feet high, are special Alcoa extruded "H" sections, having a depth of 10 inches and unbalanced flanges 6 and 8 inches wide. They are designed thus to facilitate setting of stop-logs and to provide maximum strength with a minimum of metal.

Aluminum reduces the weight to a point where all parts can be man-handled, thereby obviating the use of any equipment for the erection process. It provides the necessary high strength, yet gives minimum bulk for storage. Because Aluminum does not rust, the equipment can be stored for years without loss of strength.

These structures demonstrate how the extrusion process can provide shapes to meet special requirements. Produced at moderate tool costs, they avoid the expense and delay incidental to reworking or assembling standard structural shapes. ALUMINUM COMPANY OF AMERICA, 2108 Gulf Building, Pittsburgh, Pennsylvania.

ALCOA · ALUMINUM

CONTRACT UNIT PRICES

What contractors are bidding on different kinds of construction work

BRIDGE, MASSACHUSETTS

OWNER. Dept. of Public Works, Commonwealth of Massachusetts, J. W. Beal, commissioner; R. W. Coburn, chief engineer.

PROJECT: Construction of steel truss and stringer bridge with bituminous concrete approaches, over Hoosic River and Boston & Maine RR., North Adams, Mass. Total length, including approaches 1,553 ft.; bridge proper, 12 spans, is 938.37 ft. long. Concrete abutments and piers on wood and steel piles. Roadways of concrete 40 to 46 ft. wide. Bridge is approximately 11-ft. above normal water level; south end is practically at flood level. Alternate bids were asked on Colprovia or Warcolite bituminous paving materials; on cement concrete or vitrified clay pipe for sewers; and on special alloy steel or wrought iron blast plates. Contract awarded on first of alternates mentioned.

CONDITIONS: Contractor to furnish all materials and complete work by August 2, 1941. Includes some ledge rock excavation. Two channel piers are on steel piles to bed rock. Other piers are on wood piles to hard pan. Rail and highway transportation facilities available. Wages are: skilled 75c. per hr.; semi-skilled, 65c.; and common, 62½c. per hr.

BIDS: Thirteen bids were opened May 21, 1940, ranging from the contract low of $367,577 to $509,916.

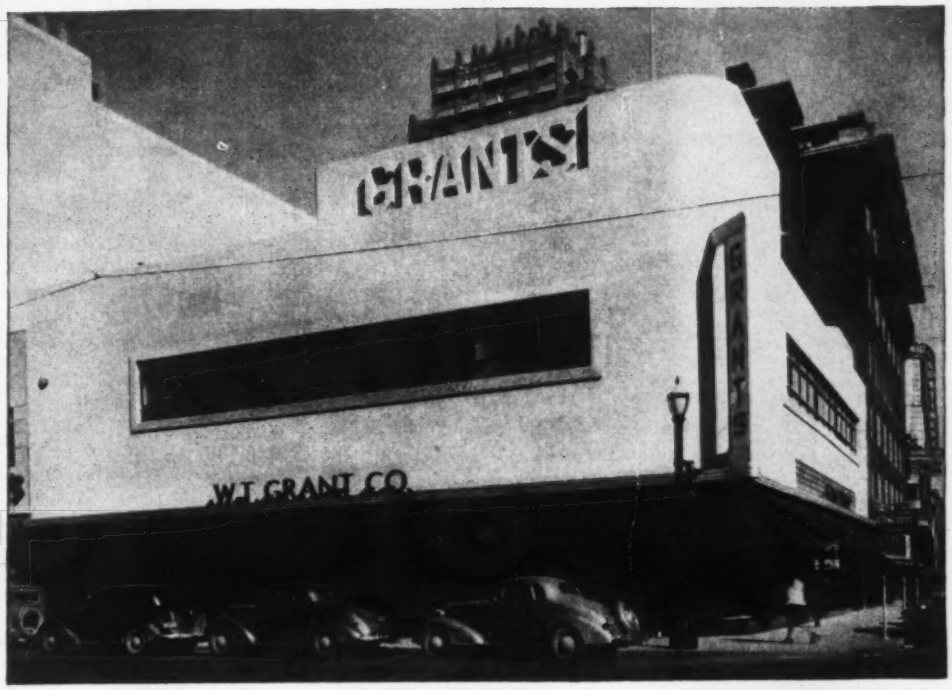
LIST OF BIDDERS:

1.	Carlo Bianchi & Co., Framingham, Mass. (contract)	$367,577
2.	Lane Constr. Co., Meriden, Conn.	378,458
3.	Vulcan Constr. Co., Boston, Mass.	398,761
4.	Coleman Bros. Corp., Boston, Mass.	402,150
5.	J. F. Fitzgerald Co., Boston, Mass.	411,272
6.	DeLiso Constr. Co., Springfield, Mass.	429,813
7.	Lindholm Constr. Co., Pittsfield, Mass.	435,590
8.	A. Baruffaldi Co., Somerville, Mass.	445,396
9.	Howes & Farrel, Inc., Listie, Pa.	456,486
10.	C. I. Hosmer, Greenfield, Mass.	459,954
11.	Clevorock, Inc., New York, N. Y.	487,169
12.	G. Bonazolli & Son, Hudson, Mass.	508,433
13.	Foley Bros., Pleasantville, N. Y.	509,916

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Roadway earth excav	7,000 c. y.	$0.30	$0.25	$0.30
2. Ledge excavation	2,100 c. y.	2.00	2.50	2.75
3. Cem. conc. surf. excav	80 c. y.	2.00	2.00	2.75
4. Granite paving blocks, remove and salvage	1,000 s. y.	.30	.30	.40
5. Bridge excavation	5,200 c. y.	2.50	2.85	5.00
6. Trench excavation	2,400 c. y.	1.00	1.00	1.00
7. Channel excavation	1,400 c. y.	.75	1.00	1.00
8. Trench ledge excav	850 c. y.	5.00	3.50	3.50
9. Concrete excavation	180 c. y.	5.00	3.00	5.00
10. Remove trees	6 ea.	10.00	10.00	10.00
11. Ordinary borrow	4,000 c. y.	.40	.35	.45
12. Gravel borrow	7,500 c. y.	.40	.65	.60
13. Sand borrow	250 c. y.	1.00	1.25	1.00
14. Strip gravel pits	770 c. y.	.10	.10	.05
15. Scarify and reshape	400 s. y.	.25	.10	.20
16. Calcium chloride, subbase trtmt.	20,000 lb.	.03	.02	.03
17. Fine grading	26,000 s. y.	.04	.03	.03
18. Crushed stone base	560 c. y.	4.50	5.00	5.00
19. Crushed stone fill	320 c. y.	2.50	2.50	4.00
20. Cement conc. base	520 c. y.	9.00	7.25	10.00
21. Bit. for tack coat	200 gal.	.20	.25	.25
22. Gravel surfacing	200 c. y.	1.00	.75	1.00
23. Bit. for surf. treatment	7,000 gal.	.15	.09	.10
24. Cr. stone, macadam surf	400 c. y.	5.50	6.00	5.00
25. Bit. for macadam surf	14,000 gal.	.10	.09	.10
26. Cl. I bit. conc. pavement (Colprovia)	970 ton	7.50	6.50	8.00*
27. Reinf. steel for conc	300 lb.	.10	.05	.10
28. H. E. S. cem. conc. pavement	10 c. y.	20.00	10.00	15.00
29. Brick pavem't, remove, relay	150 s. y.	1.00	1.25	1.00
30. Granite block, remove, relay	150 s. y.	1.00	1.50	1.00
31. Steel sheeting	150,000 lb.	.054	.04	.06
32. Lumber sheeting	5.5 Mbm.	80.00	125.00	150.00
33. Timber pile loading tests	2 ea.	100.00	150.00	300.00
34. Timber piles	5,800 l. f.	.50	.70	1.00
35. Steel H piles	54,000 lb.	.05	.05	.08
36. Steel pile loading tests	2 ea.	100.00	150.00	350.00
37. Steel pile splices	10 ea.	20.00	10.00	12.00
38. Cement conc. masonry, Cl. A	4,200 c. y.	15.00	15.75	14.00
39. Cement conc. masonry, Cl. C	3,400 c. y.	12.00	9.75	14.00
40. Cement conc. masonry, Cl. D	90 c. y.	18.00	12.00	14.00
41. Rein. steel, structures	701,000 lb.	.034	.04	.04
42. Cemented stone masonry	145 c. y.	10.00	10.00	10.00
43. Cement for grouting	50 bbl.	15.00	5.00	6.00
44. Cement for pointing	5 bbl.	15.00	25.00	12.00
45. Bit. damp-proofing	4,716 s. y.	.25	.10	.20
46. Waterproofing, curbs	7,200 s. f.	.04	.10	.05
47. Structural steel	2,195,000 lb.	.045	.0525	.05
48. Welded bridge railings	1,543 l. f.	6.60	7.00	6.00
49. Welded steel plate	298 l. f.	12.25	12.10	12.00
50. Welded br. stair railings	245 l. f.	5.50	5.25	5.00
51. Steel pipe barrier railing	48 l. f.	3.00	4.00	3.00
52. Blast plates spec. alloy steel	88,000 lb.	.05	.05	.08
53. Gunite	15,500 s. f.	.43	.45	.40
54. Riprap	1,300 ton	4.00	3.00	1.65
55. Remove 2 exist. bridges	L.S.	500.00	500.00	250.00
56. Relocate exist. plate girder br.	L.S.	7,500.00	3,000.00	3,000.00
57. Sidewalk grating	530 s. f.	1.50	1.75	1.80
58. Scuppers for roadway	18 ea.	15.00	15.00	15.00
59. Scuppers for sidewalk	4 ea.	30.00	30.00	16.00
60. Snow disposal manholes	1 ea.	25.00	100.00	75.00
61. Safety stair treads	370 l. f.	1.00	.75	.80
62. Electr. street lighting	L.S.	3,000.00	3,000.00	2,500.00
63. Catch basins	24 ea.	55.00	75.00	70.00
64. Manholes	13 ea.	55.00	80.00	90.00
65. Catch basin fr. with grates or manhole fr. with covers, remove and salvage	9 ea.	5.00	10.00	2.00
66. Remove salv. reset c. basin grate	1 ea.	5.00	15.00	5.00
67. Adj. c. basin or m.h. to grade	4 ea.	25.00	15.00	10.00
68. 6-in. vitr. clay pipe	18 l. f.	.50	.40	.50
69. 12-in. cement conc. sew. pipe	1,220 l. f.	.60	.55	.75
70. 15-in. cement conc. sew. pipe	290 l. f.	1.00	.85	1.25
71. 18-in. cement conc. sew. pipe	540 l. f.	1.50	1.10	1.50
72. 24-in. cement conc. sew. pipe	90 l. f.	2.50	2.00	3.00
73. 12-in. rein. conc. pipe	60 l. f.	1.25	1.15	1.25
74. 12-in. heavy wt. c. i. culv. pipe	60 l. f.	2.00	1.75	2.00
75. 18-in. heavy wt. c. i. culv. pipe	12 l. f.	3.50	3.00	4.00
76. 24-in. heavy wt. c. i. culv. pipe	12 l. f.	6.00	5.00	7.00
77. 30-in. heavy wt. c. i. culv. pipe	12 l. f.	10.00	8.00	10.00
78. 3-in. cast iron soil pipe	125 l. f.	.50	.60	.60
79. 6-in. cast iron soil pipe	210 l. f.	.90	1.00	1.00
80. 4-in. wr. iron pipe	300 l. f.	3.00	2.00	4.00
81. 8-in. wr. iron pipe	20 l. f.	5.00	3.00	3.50
82. 6-in. perf. bit. coat. cor. met. pipe side drain	90 l. f.	1.50	1.25	2.00
83. 12-in. pipe culv.; remove, relay	20 l. f.	1.00	.50	1.00
84. Highway guard, type W 2 C	210 l. f.	.75	1.00	.90
85. Highway guard, type C 2 C	300 l. f.	.75	.60	1.00
86. Stock fence	115 l. f.	.20	.25	.20
89. Stock fence gate	1 ea.	10.00	15.00	15.00
90. Highway guard, type M S C	510 l. f.	1.00	1.00	1.10
91. Highway guard posts, Type M-C	25 ea.	3.00	2.50	5.00
92. Highway guard end anchors	4 ea.	40.00	35.00	40.00
93. Chain link fence, 60-in. high	215 l. f.	2.50	2.25	2.40
94. Chain link fence, 72-in. high	60 l. f.	2.00	2.00	2.50
95. Chain link fence gates	15 l. f.	10.00	8.50	10.00
96. Barrier fences	100 l. f.	3.50	3.00	3.00
97. Remove and reset fence	250 l. f.	.50	.40	.40
98. Remove and stack fences	100 l. f.	.50	.40	.25
99. Remove, rebuild stone mas. walls in cement mortar	40 c. y.	10.00	10.00	10.00
100. Str. granite curb, type VA	920 l. f.	1.10	1.15	1.00
101. Curv. granite curb, type VA	115 l. f.	1.30	1.60	1.25
102. Str. granite curb, type VB	850 l. f.	.90	1.15	.90
103. Curv. granite curb, type VB	495 l. f.	1.10	1.60	1.15
104. Gran. curb. inlets, str.	15 ea.	15.00	16.00	12.00
105. Gran. curb inlets, curved	3 ea.	20.00	20.00	15.00
106. Gran. curb corners, 2-ft. rad	18 ea.	6.00	8.00	6.00
107. Conc. curb, type VA, str	25 l. f.	1.25	1.50	1.40
108. Remove and reset curb	375 l. f.	.40	.50	.30
109. Remove and stack curb	350 l. f.	.40	.50	.20
110. Remove, reset curb inlets	1 ea.	5.00	5.00	5.00
111. Remove, stack curb inlets	2 ea.	5.00	5.00	2.00
112. Granolithic walk	1,000 s. y.	1.40	2.50	1.80
113. Bit conc. walk surf	25 ton	9.00	8.00	8.00*
114. Cr. stone base for walk	50 c. y.	6.00	5.00	5.00
115. Bitum. for walk base	1,150 gal.	.20	.07	.10
116. Traffic signal conduit (B.F.)	240 l. f.	.50	.75	.30
117. Bounds	61 ea.	5.00	6.00	6.00
118. Conc. pipe well	L.S.	350.00	150.00	500.00
119. Lawn sodding	150 s. y.	1.00	.75	.60
120. Field sodding	1,300 s. y.	.50	.50	.40
121. Seeding	4,700 s. y.	.05	.05	.06
122. Loam borrow	950 c. y.	1.00	1.25	1.00
123. Loam excav., storage and re-handling	60 c. y.	2.00	1.00	1.00
124. Transplant trees, shrubs	L.S.	50.00	25.00	100.00
125. 4-in. c. i. water main and spec.	30 l. f.	3.00	5.00	1.50
126. Remove and reset hydrant	1 ea.	35.00	75.00	30.00
127. Remove and salvage hydrant	1 ea.	25.00	50.00	15.00
128. Relocate 2-in. water pipe	L.S.	100.00	200.00	500.00
129. Relocate 2-in. gas pipe	L.S.	100.00	500.00	400.00
130. Remove and dispose of bldgs.	L.S.	3,500.00	2,300.00	2,100.00

*Warcolite.

'Incor' Saves 3 Ways



CUTS TIME AND FORM COSTS ... EARLIER OCCUPANCY, TOO

UNFORESEEN delays are always cropping up in building construction. When schedules get behind, remember to call on 'Incor' 24-Hour Cement to make up lost time, as did Thos. S. Byrne, Inc., contractor for the new W. T. Grant Company Building, Fort Worth, Tex. And once again 'Incor' made good, enabling the contractor to turn the new concrete frame structure over to the owner on time.

But more and more these days, 'Incor' is being used on jobs where there isn't any special need for hurry, except as faster erection schedules show a lower concreting cost. On many jobs, 'Incor' produces nice money savings, for these reasons: Dependable 'Incor' high early service strength cuts costs through rapid form re-use—one form-set with 'Incor' often does the work of two or three; and faster completion reduces time or overhead costs, too. In addition, 'Incor' often means earlier occupancy for the owner. A 3-way 'Incor' advantage.

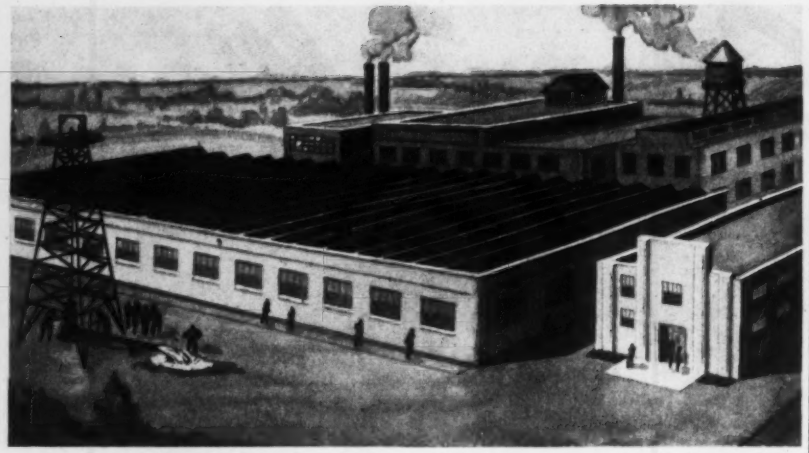
It pays to figure every job with both Lone Star and 'Incor'; use 'Incor'* where dependable high early strength shows you a profit; elsewhere, use Lone Star, quality standard ever since 1900. Write for "Cutting Concrete Costs." Lone Star Cement Corporation, Room 2289, 342 Madison Avenue, New York. *Reg. U. S. Pat. Off.

QUALITY PAYS . . . INSIST ON 'INCOR'

'Incor' 24-HOUR Cement means just what the name says—uniform, dependable 24-HOUR service strength. AND LONG-TIME DURABILITY, TOO—proved by 13-year performance record . . . a vital advantage EXCLUSIVE with 'Incor', the FIRST high early strength Portland Cement. Quality pays . . . because better cement makes better concrete.

LONE STAR CEMENT CORPORATION

MAKERS OF LONE STAR CEMENT • • • 'INCOR' 24-HOUR CEMENT



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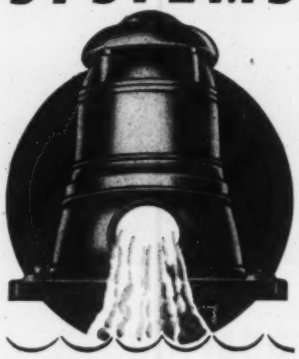

● **First:** back of Layne there are over fifty years of outstanding success—the kind of success that only satisfaction and performance could win. ● **Second:** Layne offers world-wide experience in the mastering of every geological, mechanical and water production problem. And, ● **Third:** Layne wells and pumps possess exclusive, patented and thoroughly proven advantages.

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MEN AND JOBS

HOWARD S. REED, former chief engineer of the Arizona State Highway Department, has been appointed construction adviser on the $1,700,000 slum clearance housing project at Phoenix, Ariz.

CARTZ L. WINDENBURGH, Zelienople, Pa., has been named assistant construction engineer of the Pennsylvania State Highway Department.

MARSHALL WILLIAMS, civil engineer and assistant to the president of the American Bridge Co., Pittsburgh, has retired. Williams, a graduate of Rutgers University, for a time was assistant engineer at the Pittsburgh Testing Laboratories. In 1901 he joined the American Bridge Co. as assistant to the operating manager of the Pittsburgh Division. In 1912 he was made operating manager of the Pittsburgh Division to be in charge of plants at Ambridge, Pa., Shiffler, Pa., Toledo and Canton, Ohio.

JOSEPH GOODMAN, commissioner of the department of water supply, gas and electricity of New York City, retired June 8. Goodman, who joined the old bureau of water supply in 1901, supervised many important municipal projects.

JOHN A. BECKER, general manager of the Wisconsin Development Authority, has resigned and his duties have been taken over by KENT WOOLDRIDGE, chief engineer of the organization. Becker, who is in ill health, is resting at his home in Hartford, Wis.

NEIL BORGQUIST, civil engineer, has begun new duties as junior engineer with the water department of the city of Pasadena, Calif. Borgquist received his engineering education at the University of Arizona and the California Institute of Technology.

JOSEPH W. BARBER, dean of the school of engineering at Columbia University, was awarded an honorary degree of doctor of laws June 10 at the Bucknell University commencement.

HERMAN H. PLEMMONS, sanitary engineer with the North Carolina State Board of Health for the past several years, has resigned to accept a position with the engineering department of the Nantahala Power & Light Co., Franklin, N. C. Plemmons has been directing sanitary engineering operations in Macon and Swain counties.

LIEUT. JOSEPH L. JOHNSON, who has been in charge of foundation explora-